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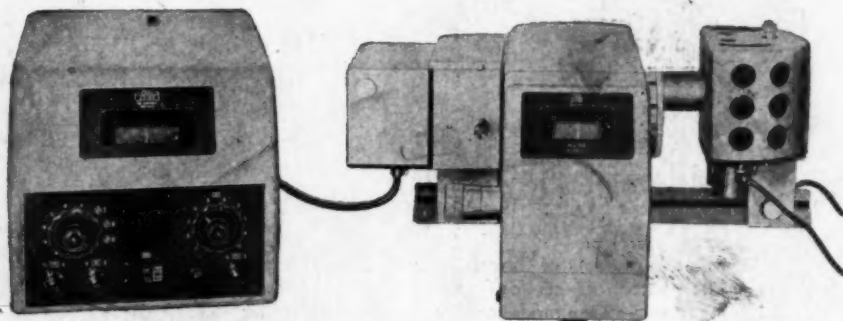
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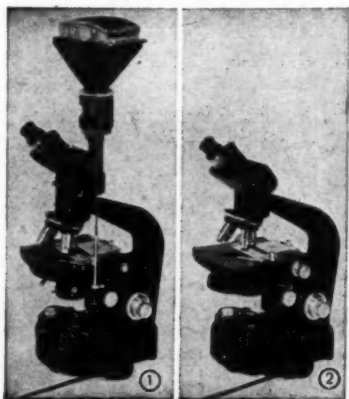
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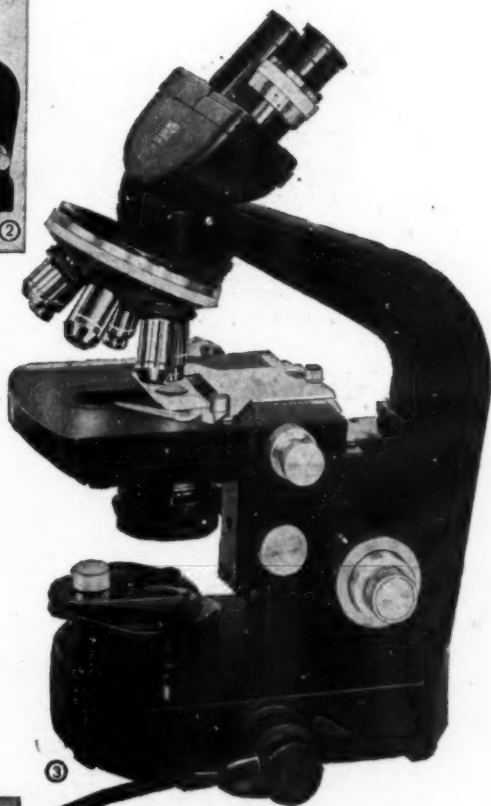


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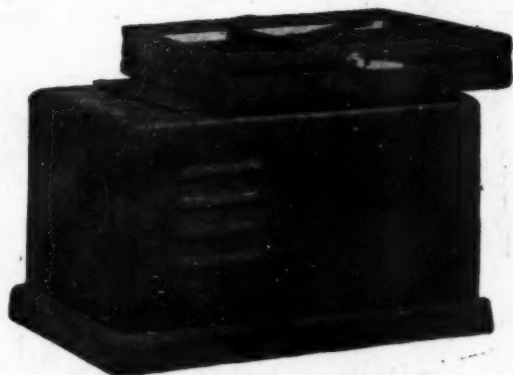
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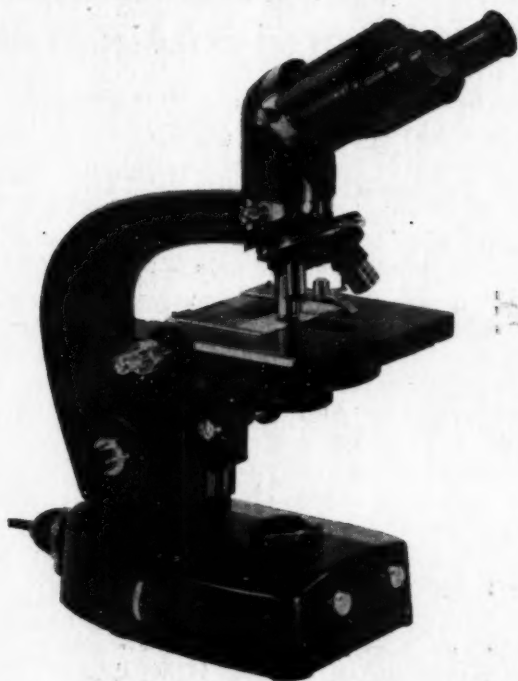
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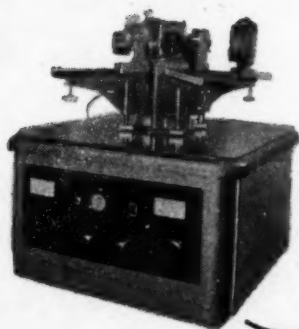
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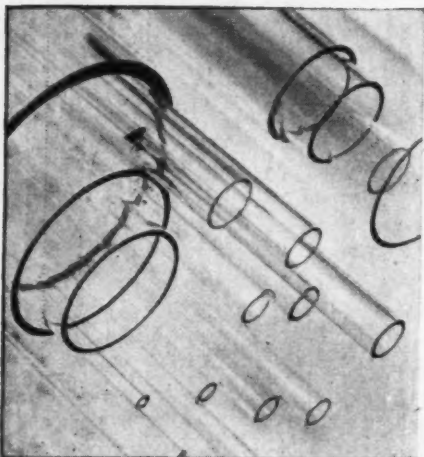
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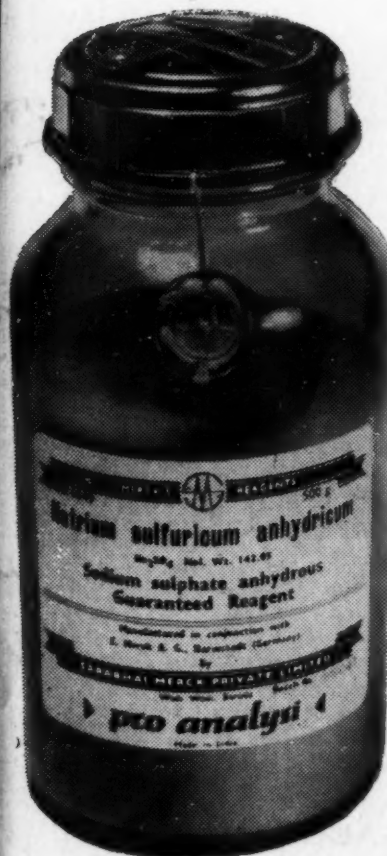
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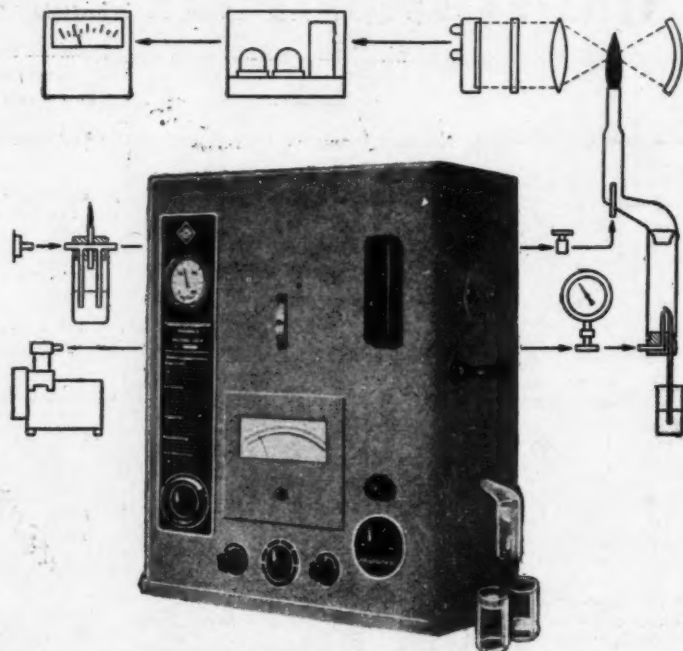


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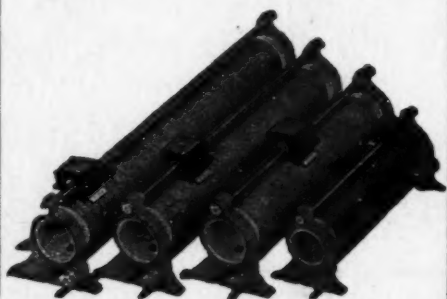
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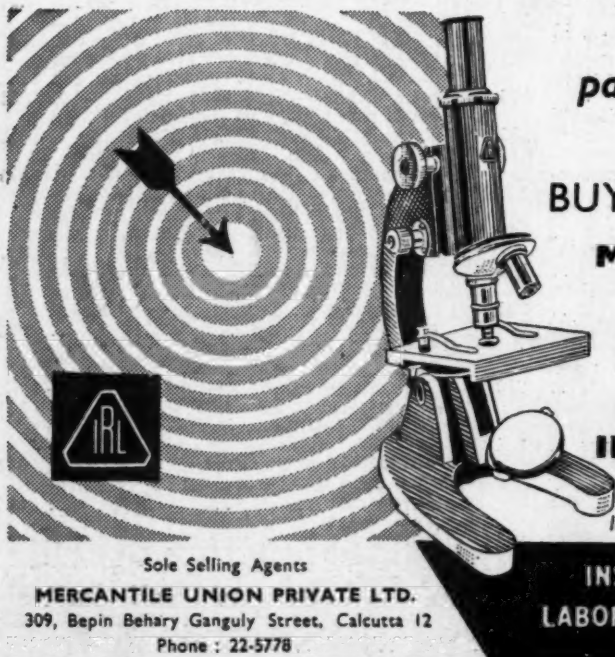
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INCREASED FOOD PRODUCTION WITH HYBRID MAIZE

E. W. SPRAGUE, N. L. DHAWAN AND L. R. HOUSE

Co-ordinated Maize Breeding Scheme, Botany Division, Indian Agricultural Research Institute, New Delhi

INTRODUCTION

NO development in the field of biological sciences, within the last fifty years, has contributed more towards the removal of want and hunger in the world than the exploitation of hybrid vigor for the improvement of cultivated plants and domestic animals. This achievement

per acre. This high average yield has been obtained by growing hybrids of higher yielding potential in association with improved agronomic practices.

HISTORY OF MAIZE BREEDING IN INDIA

Although maize has been grown in India for about three centuries, and at present covers an

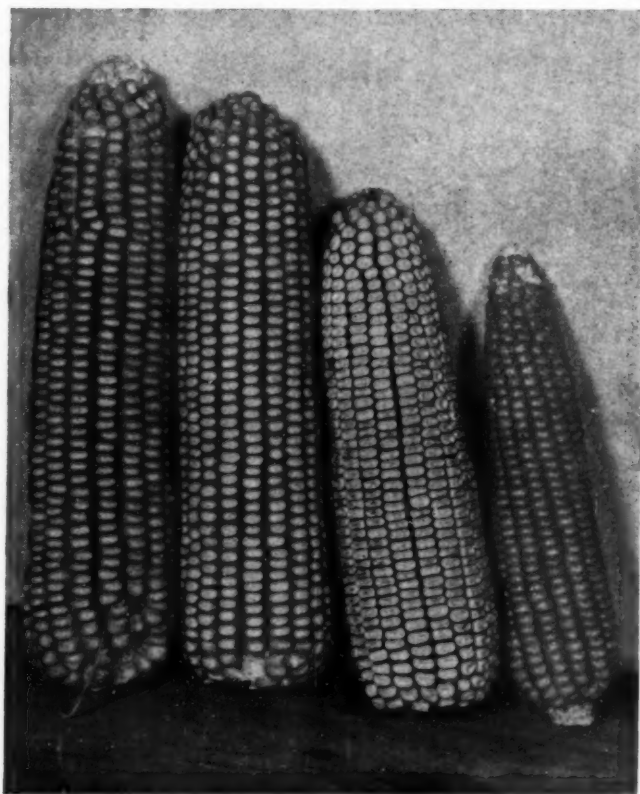


FIG. 1. *Left to Right* : Two ears of experimental hybrids, an ear of U.S. Hybrid and one ear of Desi maize.

has been particularly spectacular in maize in the United States of America, and later in other regions of the world such as Mexico, Colombia, Southern Europe and Australia. The better maize growing areas of the United States have obtained an average grain yield of 44 maunds

area of little more than nine and a half million acres with an average grain yield of about 7 maunds per acre, it is only recently that research has been undertaken towards the development of hybrid varieties. In 1945 the Indian Council of Agricultural Research, in

conjunction with the Punjab State Department of Agriculture, initiated a project on maize breeding along the lines of work done in the United States of America. Another project was started at the Indian Agricultural Research Institute in 1947 for studying fundamental problems relating to the exploitation of hybrid vigor in maize. In subsequent years research along these lines was also initiated in several other States. During this period, two hybrids, namely, Punjab Hybrid No. 1 and a three-way cross, were developed from Indian open pollinated varieties and hybrid seed was distributed to the farmers on a limited scale. These hybrids gave on an average 15 to 20% more yield than open pollinated varieties under cultivation. Although some gain had been made, it was not as spectacular as those achieved by maize breeders in the U.S.A. Research at the Indian Agricultural Research Institute revealed that indigenous open pollinated varieties lacked the requisite amount of genetic diversity needed for the expression of marked heterosis, as had been experienced by workers in other parts of the world.

During the early phases of the maize breeding efforts about 54 representative hybrids of different maturity groups from the United States of America and Australia were brought into the Indian maize breeding program, and tested at several locations of the maize growing areas. Several of the better adapted of these U.S. hybrids out-yielded the local open pollinated varieties by 80-120%. On the basis of the best performance of the best U.S. hybrids such as U.S. 13, Illinois 1656, N.C. 27 and Texas 26, a limited program of their production and distribution has been carried out in Jammu and Kashmir, Punjab, Uttar Pradesh, Andhra Pradesh and Delhi. Although this was very encouraging, it was soon found that there was considerable difficulty in maintaining the parental inbreds of the U.S. hybrids in most parts of India. Moreover, the dent grain character of the U.S. hybrids was discriminated against by the farmers. Tests with the U.S. hybrids did point out, however, that the yield of maize could be greatly increased in India, if desirable germ plasm could be obtained. The study of the U.S. hybrids also gave the Indian maize breeder a better idea of what to look for in the way of a good hybrid.

In 1954 Drs. E. J. Wellhausen and U. J. Grant of the Rockefeller Foundation Programs in Mexico and Colombia came to India on invitation from the Government of India and visited the maize research stations. They submitted a valuable report upon completion of their studies. Keeping in mind the points brought out by the

Rockefeller Foundation team, the Indian Council of Agricultural Research revised the organization of the maize breeding projects and formulated in 1957 the Co-ordinated Maize Breeding Scheme on a regional basis with thirteen co-operating research stations under one co-ordinating office. In 1960 three new research stations were added in Sikkim.

PROGRESS IN RESEARCH

With the inception of the Co-ordinated Maize Breeding Scheme in 1957, representative samples of maize germ plasm were introduced from virtually all of the maize growing regions of the world. This vast collection of seed stock represents a wide spectrum of genetic variability and of superior germ plasm. The maize breeders in India are, therefore, now in a very fortunate position and have an excellent opportunity for making rapid progress towards increased food production through the exploitation of genetic diversity and heterosis.

Fortunately a very large percentage of these introduced exotic types are strikingly well adapted to Indian agro-climatic conditions and can, therefore, be successfully utilized in the hybrid maize project. In fact the open pollinated variety, Amarillo de Cuba, a composite of several strains from the Caribbean region put together in Mexico, is well adapted in most of the maize growing areas. It has been the parental source of a group of new agronomically desirable and high combining inbred lines developed in India.

In the last three years over 5,000 inbred lines have been evolved and tested and about 90 of the outstanding ones have been selected for use in the development of hybrids suited to Indian conditions. The results show that many sources of foreign as well as indigenous germ plasm are contributing lines of high agronomic character and high yielding ability. These cream lines represent parental germ plasm originating from India, U.S.A., Cuba, Colombia (South America) and Peru (South America). About 35 of them have been put into all possible single cross combinations in such a way that the performance of double cross hybridizations from these lines can be predicted very accurately by an established procedure, and the yields of over 6,000 double crosses will be predicted in 1960. From this large number of possible hybrids it is felt that there will definitely be a suitable hybrid for each maize growing area in India by 1962. These new hybrids should, contrary to the U.S. hybrids, be composed of lines that are agronomically good

and can easily be produced in all parts of India, moreover these hybrids are expected to yield as well as U.S. hybrids. Also their grain type, color and agronomic characters will be readily accepted in India.

Simultaneously with the inbreeding program an effort has been made to use foreign inbred lines and single crosses in new combinations. U.S. lines have been put together with Colombian and Indian lines. These combinations take advantage of the flint character of the

cess, there are several other factors that present problems.

Maize like all crops is confronted with diseases and insects. The problems must be attacked by the various disciplines concerned. Some of the problems can be overcome by breeding for resistance but others defy the efforts of the breeders and only through a team approach of a breeder, pathologist and entomologist, can all of the problems be understood and efficiently challenged. By the same token,



FIG. 2. Note the large stalks and ears of the hybrid on the left compared with the local variety on the right. Also note the superior plant aspect of the hybrid.

Colombian and Indian material and the experimental double crosses under trial show a considerable degree of promise. It remains to be seen whether the foreign lines in new combinations will be suitable for release and production over a large area of India, because of disease susceptibility and line maintenance difficulties which are not so extreme in the case of Indian bred inbreds.

PROBLEMS AND NEEDS

Although progress in breeding for higher yields in maize has met with considerable suc-

cess, there are several other factors that present problems. It is generally accepted that hybrid maize expresses its greatest advantage under high fertility, adequate moisture and good drainage. With these questions unanswered, the agronomist must join the research team.

* With the four disciplines forming a well co-ordinated team battling the problems of maize production, there is great hope that hybrid maize can perform for India, as it has done for other parts of the world.

THE DESIGN AND USE OF A Co^{60} IRRADIATION UNIT IN THE UNITED STATES EXHIBIT, WORLD AGRICULTURAL FAIR

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A Co^{60} irradiation facility was installed and operated in the United States Pavilion at the World Agricultural Fair in New Delhi from December 11, 1959 to March 1, 1960. The unit was designed for the gamma irradiation of biological and other research materials as well as for demonstrational purposes, and operated as a service unit to scientists throughout the Fair. The following description of the unit and discussion of its uses and limitations in agricultural research is made in view of the widespread interest and use which the unit evoked from Indian scientists.

DESIGN OF THE FACILITY

The cobalt-60 facility was designed, fabricated and installed under the direction of Mr. Otto Kuhl of the Nuclear Engineering Division of Brookhaven National Laboratory, under contract for the U.S. Atomic Energy Commission. The total strength of the radioactive Co^{60} source was 4,750 curies, distributed more or less evenly among nine steel-encased cobalt plates. The plates were placed in radiation chambers at the bottom of a pool of filtered water, 10 feet deep, ensuring that no appreciable radiation (0.3 mr./hr.) occurred at the water-surface. The pool was surrounded by glass panels, and materials to be irradiated were lowered into the pool from a platform 3 metres above water-level. The nine cobalt plates employed in the facility measured $2\frac{1}{2} \times 13$ " and about $\frac{1}{8}$ " in thickness. Each of these plates had been exposed for nearly two years to the neutron flux in Brookhaven's pile-type reactor and contained approximately 500 curies of Co^{60} . The plates had a specific activity of about 2 curies per gram.

Four cylindrical irradiation chambers were designed to accommodate the cobalt plates, and were spaced one metre apart at the bottom of the pool. The plates were arranged vertically in the walls of the irradiation chambers. Materials to be irradiated were placed in watertight steel containers which could be guided neatly into the hollow core of the chambers. The containers were lowered by winch, two of which were operated by automatic power units. The outer diameters of the 4 containers were $2\frac{1}{4}$ " for containers 1 and 4, 4" for container

2, and 3" for container 3. The four chambers were operated throughout most of the Fair with 1, 2, 4 and 2 cobalt plates in chamber 1, 2, 3 and 4 respectively.

The ferrous sulphate oxidation method¹ was used to calculate the gamma radiation dosages. The spectrophotometric measurements were carried out within an hour of irradiation at the Division of Mycology and Plant Pathology of the Indian Agricultural Research Institute. On the 1st of January 1960, the calculated dosages were 30 150 rad./hr. in chamber 1, 60 230 rad./hr. in chamber 2, 185 150 rad./hr. in chamber 3, and 102 850 rad./hr. in chamber 4. These were readjusted down by one per cent. monthly thereafter to compensate for decay. The dose rate dropped by as much as 30% from the centre to the periphery of the containers; hence samples were irradiated in the central core of the chambers insofar as possible.

USE OF THE FACILITY

The gamma irradiation facility proved to be a very popular exhibit with the general visitors, owing to the blue Cerenkov glow seen in the water when the lights were switched off. The great potentialities offered by this excellent research tool also attracted the interest of numerous scientists and scientific institutions in India; as a result, the irradiation chambers were loaded with material received from all over the country throughout the duration of the Fair. This made the exhibit a very unique and distinctive one and it will take several years for the investigators who had material irradiated to analyse fully the effects induced by the dosage given.

A total of 4,757 samples submitted by 94 research workers were irradiated during the 81 operating days of the Fair. About 160 types of research materials were handled, including (1) seeds of 111 different species, (2) roots, tubers and cuttings of 20 species, (3) pollen and embryos of 11 species, (4) 10 species of micro-organisms, and (5) miscellaneous items such as culture media, fruits, fern spores, chemical solutions, glass slides, cylinders and white rats. In view of the great diversity of the material treated, the dosages given varied widely, ranging

from 200 rads to 3 million rads. The item "rads" refers to the gamma dosage as calculated by the chemical indicator techniques. In general practice this may be considered equivalent to the more familiar unit, "r" or roentgen. Most investigators left to the discretion of the operators the dosages to be administered. Whenever the approximate LD-50 (50% lethal dose) was already known, the material was treated with several dosages, keeping the LD-50 dose as the modal class. For seeds of cereals like wheat and barley the LD-50 dosage lies between 15,000 and 30,000 rads. On the other hand, for plants like mustard and linseed, the LD-50 dosage is over 100,000 rads. For seed material, the treatments thus ranged from 1,000 to 300,000 rads. Cultures of *Penicillium*, *Streptomyces* and other micro-organisms were given dosages about a modal class of 25,000 rads. This modal dosage was 3,000 rads for most tubers and cuttings. For material such as seeds of water chestnut (*Trapa nutans*) and cuttings of tapioca (*Manihot utilissima*), for which no previous data existed, a broad range of treatments was given. A dose of 800 rads was delivered to rats; for treating them, a special container equipped with air hoses was lowered to a point on the floor of the pool where the dose rate was approximately 2,400 rads per hour. Special chambers were also designed to treat seeds in a pure oxygen atmosphere. Thus, the set-up of the source offered sufficient scope to undertake critical experiments on a wide range of radiobiological problems.

INDUCED MUTATIONS AND PLANT BREEDING

Over 90% of the material irradiated at the Co^{60} unit came from plant breeders. The primary interest in these cases was that of the induction of mutations of economic value. In view of the widespread interest of plant breeders in India in the technique of mutation breeding, a few general comments here may not be out of place.

Firstly, huge quantities of seed material (several pounds of paddy seeds, many ounces of tobacco seed, etc.) were often sent for irradiation. While it is presumed that these seeds may be derived from essentially homozygous lines and that suitable controls might have been kept by the investigator, it was apparent that some of the plant breeders who sent samples expected to isolate mutations in the first generation following treatment. While some genetically-controlled phenotypic changes, resulting largely from the deletion of epistatic genes, may be manifested in the year of treatment (parti-

cularly in polyploid plants),² it is essential that the second and further generations of the irradiated material should be grown to detect the recessive mutations which constitute a vast majority of induced mutations.

Secondly, recent results^{3,4} have emphasized that following irradiation, even a self-fertilised plant is cross-pollinated to a great extent owing to varying degrees of radiation-induced pollen sterility in the X_1 plants (plants grown from irradiated seed). It thus becomes necessary in critical experiments to make controlled self-pollinations of each X_1 plant and to grow its progeny separately during the next season. Unless such care is taken, segregation in X_2 lines cannot be attributed to mutation with any degree of certainty. Experiments carried out at the I.A.R.I. have shown that it would be preferable in plants like wheat and paddy to harvest and sow the seeds from every ear of X_2 plants separately. Thus, a plant breeder who has 200 to 300 X_1 plants will have a very large material to handle and study during the X_2 generation. It is now well established that success in mutation breeding will depend on the size of the X_2 and subsequent populations and the efficiency of the screening procedures adopted. An intimate knowledge of the cytogenetic make-up of the plant is also highly desirable. Taking to mutation research as a part-time activity may hence lead the research worker nowhere both from the applied and fundamental points of view.

Thirdly, some research workers interested in pollen irradiation sent samples of pollen from plants like wheat. An essential prerequisite in such work is information concerning the duration for which pollen remains viable. As a rule, trinucleate pollens lose their viability a few hours after anthesis while in plants in which the pollen is binucleate at the time of anthesis, the viability extends over several days and even months.⁵ The pollen grains of wheat and paddy are trinucleate and hence the duration for which they remain viable is very short (a few hours at the maximum). Sending pollen of such plants over long distances for irradiation and later using them for pollination will hence be a futile process.

Fourthly, a considerable number of seed samples submitted for irradiation represented highly cross-pollinated species. Although the majority of these were for use in botanical studies or research seeking unique mutant types, some were irradiated as an adjunct to plant breeding programmes with the general objective of

increasing yields. Not only is the distinction of induced mutations from natural variability impractical if not impossible in such material, but it is the conviction of most plant breeders that irradiation should be held in reserve as a source of new variability in such species until conventional breeding practices have been most thoroughly surveyed. This is particularly important in the improvement of polygenic characters, for which gene mutations of the typical recessive monogenic nature afford little promise of breeding progress. It is important as well to note that many induced mutations result from cytological aberrations which otherwise affect the plant adversely, e.g., reducing fertility and seed production.

We would like to take this opportunity to caution research scientists and administrators against the growing tendency to look upon radiation as a magic tool in plant improvement. Few countries, developed or underdeveloped, have adequately exploited in their plant breeding programmes the variability already present in the indigenous material or in material that could be introduced easily from other parts of the world. It is important therefore that plans for the use of radiation in plant breeding should not be at the expense of finance and trained personnel needed for carrying out an effective breeding programme conducted on a conventional basis. Until we know more about the experimental control of the frequencies and types of induced mutations, radiation should be considered only as a special research tool, valuable particularly in causing specific deletions or translocations and breaking tight linkage groups.

Geneticists who have reported promising results with this tool are unanimous in holding the view that plant breeders should regard this method as supplemental and not substitutional. It takes nearly as many years to convert an induced mutation into a finished product suitable for release for cultivation as it takes for breeding a new variety.

TRENDS IN GAMMA RAY INSTALLATIONS

Several hundred gamma irradiation units are presently employed throughout the world in biological, medical and agricultural research. The radioactive isotope of cobalt, Co^{60} , has been used in most of these units. The most popular types of cobalt facilities have been (1) gamma rooms, the cobalt commonly attached to the lid of a lead container which can be raised by remote control for irradiations, (2) gamma pools, such as the one described here, and (3) gamma fields, for the purpose of providing continuous irradiation

to living organisms (two such units occur in India, at the IARI and Bose Research Institute). The primary advantage of the pool-type unit is that extremely "hot" sources may be employed with great safety and minimal expense. For example, the 4,750 curie source exhibited in the pool at Delhi would require a field at least one mile in diameter, or a room provided with 50-inch thick concrete walls for reasonable safety.

Owing to its relatively short half-life of 5.3 years, Co^{60} loses about 1% of its energy monthly and needs to be recharged in a reactor fairly often. Hence other gamma emitters like Cesium¹³⁷ are presently gaining in popularity. Cesium is a fission product with a half-life of 30 years obtained from used fuel elements of a nuclear reactor and has only recently become available at a cost comparable with that of cobalt. While Cs^{137} emits a single photon of energy 0.661 Mev, Co^{60} emits two photons of gamma energy 1.17 and 1.33 Mev. As a result, a curie of Co^{60} produces a field of 1.35 r./hr. at one metre in contrast to 0.356 r./hr. given by a curie of Cs^{137} . In general the lower energy gamma rays of cesium are slightly more effective in producing biological changes such as mutations, but are considerably less penetrating. The lower energy and penetrability of Cs^{137} make it impractical for use in medical therapeutic units. However, Cs^{137} is expected to be very useful for the irradiation of biological materials in pool-type units as the one described here, in gamma rooms (as installed at the National Institute of Genetics, Mishima, Japan) or in a gamma field (as under design in Germany and Spain). Data gained from these and other Cs^{137} pilot units will help to evaluate the suitability of Cs^{137} as a partial replacement for Co^{60} in biological research.

ACKNOWLEDGEMENTS

The first author (J. L. B.) is indebted to the Brookhaven National Laboratory and the U.S. Atomic Energy Commission for deputing him to act as Director of the Co^{60} irradiation unit in the American Pavilion. The second author (M. S. S.) is grateful to Dr. M. S. Randhawa, Dr. B. P. Pal and the Ministry of Food and Agriculture for nominating him as the Scientific Liaison Officer with the U.S. Atomic Energy Commission. Our sincere thanks are due especially to Mr. Otto Kuhl of Brookhaven National Laboratory, who was largely responsible for designing and setting up the source, for all his advice and assistance. Dr. S. Majumder and Messrs. C. Bhatia, J. Prasad and M. Upadhyaya

occurred were in charge of the operation of the source and carried out a highly commendable volume of work, for which our sincere thanks are due. We are grateful to Dr. S. Bhaskaran, who was the Principal Technical Information Officer at the U.S. Atomic Energy Pavilion, for his advice and assistance.

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SUMMER SCHOOL IN BOTANY

UNDER the auspices of the Ministry of Scientific Research and Cultural Affairs, Government of India, a Summer School in Botany, the first of its kind in India, was held at Darjeeling (Eastern Himalayas, altitude 7,000 ft.) from June 2-15, 1960. Professor P. Maheshwari, Head of the Department of Botany at the University of Delhi, was Director of the Summer School. 35 representatives from the various Indian universities and scientific institutions participated in the proceedings of the School. The programme included lectures followed by presentation of papers and discussions. Fifty-four papers were presented and their scope was wide and varied. Some excursions were also arranged.

Among the topics for lectures were: Contacts between embryology, physiology and genetics (P. Maheshwari, Delhi); Rhizosphere microfloras, and Bioassay problems (T. S. Sadasivan, Madras); Botanical nomenclature (H. Santapau, Bombay); Genetics of *Coleus* (D. C. Rife, New Delhi); Origin of maize (J. Venkateswarlu, Waltair); Endemic flora of India (D. Chatterji, Calcutta); Hydroponics (J. C. Sen Gupta, Calcutta); and Buds in some Indian ferns (T. S. Mahabale, Poona).

A full afternoon was devoted to group discussions on the "Promotion of botanical teaching and research in India". The problems discussed included: Future of Plant Morphology, Plant exploration in India, New lines of work in cryptogams, Problems in genetics, Teaching of Plant physiology and ecology, and General teaching of botany. This discussion was continued on the 14th afternoon and 15th morning under the chairmanship of Professor

P. Maheshwari and the recommendations made have been forwarded to the Ministry of Scientific Research and Cultural Affairs, and the University Grants Commission.

The after-dinner talks included: Flora of Mahabaleshwar (H. Santapau), Botanical gardens in the U.K. and Europe (B. M. Johri), Spring flora of Chicago (M. Nagaraj), Flora of Eastern India (G. Panigrahi), and Phytogeography of Palms (T. S. Mahabale). All of these were illustrated with kodachromes. Professor V. Puri also showed several interesting coloured transparencies taken during his visits to Stockholm and Montreal on the occasion of the International Botanical Congresses. Professor T. S. Mahabale gave a running commentary on a technicolor film entitled the "Flora of Andamans", taken by the students of his department. Some of the shots, particularly of the gills of *Agaricus*, their opening, discharge of spores and final collapse were very fascinating. Mr. A. C. Gupta (Retired Conservator of Forests now residing at Darjeeling) showed several coloured films on the "Flora and fauna of Darjeeling and Sikkim". Through the courtesy of the Director of Publicity, West Bengal, two films on *Cinchona* and Tea plantation were also screened.

The excursions included visits to the Happy Valley Tea Estate and the Lloyd Botanic Garden which was established in 1878 and has, besides other Himalayan plants, an excellent collection of gymnosperms.

Dr. B. M. Johri, Department of Botany, University of Delhi, was the Organizer of the Summer School.

GEL-DIFFUSION STUDIES ON *TOXOPLASMA GONDII*

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GEL-DIFFUSION techniques provide a qualitative and quantitative method of measuring antigens in complex mixtures and have lately been utilised in the course of studies on the antigens of isolated cellular components in the case of certain protozoan species like *Paramecium aurelia*.^{2,3} This reaction has, in this laboratory, provided a valuable aid in determining the antibody response against the soluble antigens of *Toxoplasma gondii*. Two techniques were employed, viz., a modification of Ouchterlony's³ method as described by Mansi⁴ and a method described by Jennings and Malone.⁵ The reactions and interpretation of the results

Warren.⁶ No reaction occurred between the normal rabbit serum and the infected tissues of experimental animals like mice, guinea-pigs and pigeons and extracts and suspensions of *T. gondii*, or between immune rabbit serum and normal tissues of these animals. When immune serum was tested against such infected tissue antigens as the peritoneal exudate or the saline extracts of lung, liver, spleen and brain, a strong reaction was observed.

Usually, 3 lines of precipitation were observed, thus indicating that the organism contains at least three soluble antigens. Extracts of the organism also gave the same result. Seven

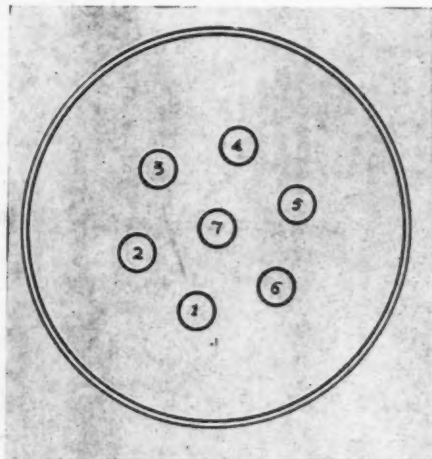


FIG. 1

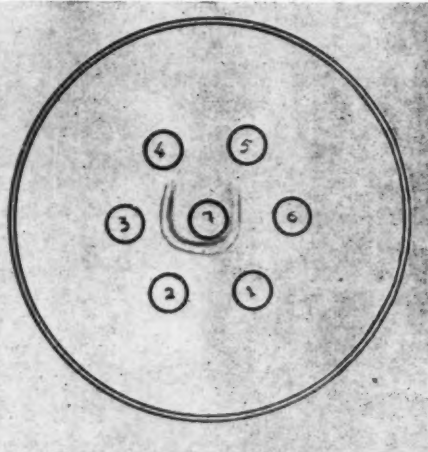


FIG. 2

FIGS. 1-2. Fig. 1. The examination of 'FS' serum absorbed with *T. gondii* strain 'RH'. The row of reservoirs 1, 3, 4, 5 and 6 contain strains RH, Ch, 113 C-E, S₅ and Beverley while reservoirs 2 and 7 contain 'FS'. No lines are formed between absorbed 'FS' serum and the other five strains while a strong line is produced in the homologous system. Fig. 2. Reservoirs 1, 2, 3 and 6 contain sera of mice infected with *T. gondii* RH strain while tissue cultures infected with *Besnoitia jellisoni* are placed in reservoirs 4 and 5. Reservoir 7 contains anti-toxoplasma hyperimmune serum. Note the double zone of reaction and its absence between reservoirs 4 and 5.

obtained with *T. gondii* were found to be essentially the same as those described by Mansi⁴ in his studies on viruses of fibroma and sarcoma. Jennings and Malone's method had the advantage that a positive reaction could be read in two hours and more distinct lines of precipitation occurred as diffusion proceeded although larger quantities of serum and antigen were required than for the method of Mansi.

Immune sera were produced in guinea-pigs and rabbits on the lines of Cutchins and

strains of the organism studied so far have produced three lines while a single strain (FS) isolated from a flying squirrel (Pande et al., 1960)⁷ gave rise to four lines, indicating possible qualitative and perhaps quantitative differences in the antigenic structure of different strains. 'FS' antiserum absorbed with the standard RH strain of *T. gondii* gave rise to a single line of precipitation on Ouchterlony plates in the homologous and none in the heterologous systems, thus further confirming the presence of

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an additional diffusable antigen (Fig. 1). It is interesting that, when tissue cultures infected with *Besnoitia jellisoni* (obtained through the kind courtesy of Dr. J. K. Frenkel, University of Kansas Medical Centre) were tested, no antigenic cross-reactivity could be demonstrated between these two morphologically similar and taxonomically closely related protozoa. It has been found that 5% formalin and 50% glycerin did not inactivate the antigens and the test can be satisfactorily carried out on infected tissues preserved with these reagents.

The sera of experimental animals dying of infection with toxoplasma, when tested against immune rabbit serum, often gave two lines of precipitation (Fig. 2) demonstrating the presence of circulating soluble antigens probably absorbed from the extensive exudates which always are shown to contain a high concentration of diffusable antigens.

By application of the gel-diffusion technique, anti-toxoplasma precipitins could be demonstrated in the serum of different species of experimental and domesticated animals and the results so obtained bore a close correlation with those obtained by Sabin-Feldman dye test and the indirect haemagglutination procedure of Jacobs and Lunde.⁸ Precipitins appeared in the circulation within 7 days after artificial infection,

reached a peak within 14 days and persisted at a very high level at least up to 4 months and 10 days, the maximum period tested so far.

Save for the reports of O'Connor,^{9,10} there is no reference in the bibliography on toxoplasmosis about the demonstration of precipitating antibodies to toxoplasma by diffusion. It is intended to use this method in investigating the antigenic composition of *Toxoplasma gondii* and its immunological relationship to other allied species of protozoa. It is also proposed to evaluate the diagnostic value of this method, on a comparative basis, to determine its usefulness in serological surveys of natural infection in the different species of wild and domesticated animals and birds in this country.

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SOLVENT EFFECTS ON THE DISPLACEMENT OF RAMAN AND ANTI-STOKES SPECTRAL LINES

MUCH interest is currently being shown in the effects of molecular interactions on the infra-red absorption spectra of simple molecules. In two articles published in the *Proceedings of the Royal Society* (1957 and 1960) A. D. Buckingham has developed a simple theory of the effects of a solvent on the frequencies, intensities and the widths of the infra-red absorption bands of diatomic molecules. The interaction potential energy U is expanded as a power series in the normal co-ordinates and treated, with the anharmonicity, as a perturbation to the harmonic oscillator. The frequency shifts are shown to be related to the first and second derivations of U and the intensities found to be dependent on the derivatives of the dipole moment of the active molecule and its near neighbours in a small macroscopic sphere enclosing it.

In a recent paper (*Trans. Farad. Soc.*, 1960, **56**, 753) Buckingham has extended the theory to take account of the influence of the solvent-shift of the energy levels on the distribution of molecules in the vicinity of the active solute. A result of this is that in the Raman Spectrum of dissolved molecules, the Raman and anti-

Stokes lines should have slightly different displacements from the exciting line.

The Raman lines arise from the absorption of a photon from the monochromatic incident beam and the immediate emission from the virtual state so formed of a photon of lower energy leaving the molecule in an excited state. Similarly, the anti-Stokes lines correspond to an excited molecule absorbing a photon and emitting another of higher energy, the molecule undergoing a transition to the lower ground state. Since the ground state molecules and the vibrationally excited molecules favour different solvent structures around them, the interaction energies will be slightly different in the two cases. Thus the different solvent environments around ground state and excited state solute molecules lead to a small difference between the displacements of the Raman and anti-Stokes lines in the Raman effect of dissolved substances. As the difference is shown to be proportional to the square of the half-width of the band, it is only appreciable when the band is broad.

LETTERS TO THE EDITOR

FADING OF C.W. SIGNALS AS A
MEANS OF SPREAD-F STUDY

CONSIDERABLE evidence has accumulated in recent years¹⁻³ pointing out the identity of the Ionospheric irregularities causing Radio Star scintillations and spread-F phenomena, and their occurrence in extensive patches of considerable horizontal extent (up to 750 km.). In view of these facts it is to be naturally expected that these irregularities should affect C.W. transmissions through the disturbed F-region. It is interesting to know how far these effects can be utilized for the study of spread-F irregularities. With this end in view C.W. Signals on 11.717 Mc./s. from a regular commercial station Colombo (Ceylon) situated at about 1,300 km. south of this station (Waltair 17° 43' N., 83° 18' E.) were recorded at night using one Hallicrafters receiver type Sx-42 in combination with a conventional D.C. amplifier and Esterline-Angus pen recorder. These recordings were coupled with simultaneous

observations of overhead Ionospheric condition by vertical pulse sounding equipment.

An index number in the range 0 to 10, as defined in an earlier communication⁴ depending on the spread-F echo height range could be assigned for each of the overhead observations as a measure of the intensity of the irregularity. Pulse soundings were made on 6.4 Mc./s. which is found to be nearly the equivalent vertical incidence frequency corresponding to the single hop F reflection which is expected to be predominant for the C.W. transmission used. An exact evaluation of this equivalent frequency does not seem to be necessary as the spread-F character (equatorial) does not vary much with 1 or 2 Mc./s. change. About 100 C.W. records were taken during the months of January to February 1959 at different times between 18-00 hrs. and 23-00 hrs. I.S.T. Of these some 46 are associated with calm local conditions ('O' index) and rest with different spread-F indices.

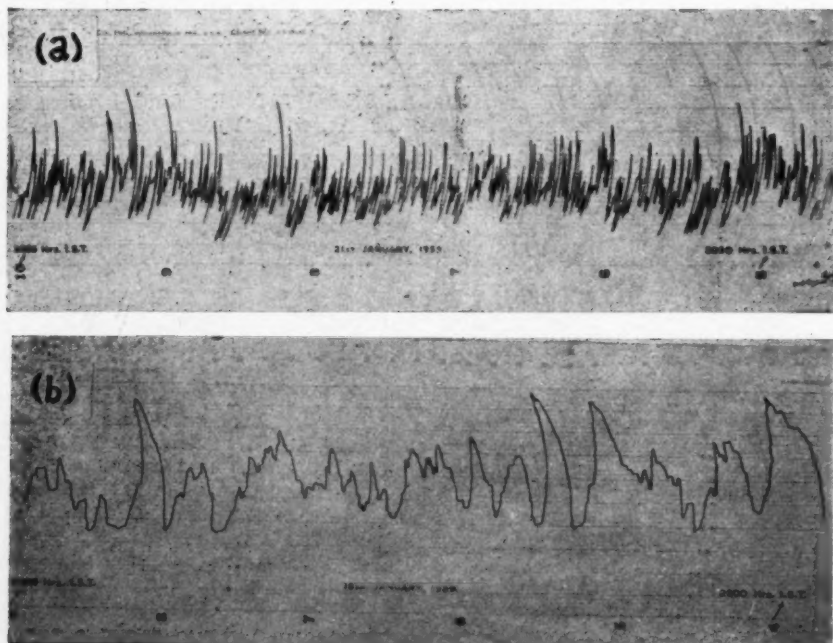


FIG. 1. Typical C.W. fading records of Colombo Transmissions on 11.717 Mc./s. received at Waltair. (a) Affected by spread-F; (b) Unaffected by spread-F.

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A striking feature in all these records is a consistent increase in the fading rate whenever spread-F is observed locally. Fig. 1 (a) and (b) show typical fading records affected and unaffected by spread-F conditions. But there are at least 8 occasions in which fading rate remained high in spite of calm local conditions. This can be reconciled with the fact that spread-F occurs more frequently at points, south of this station, approaching geomagnetic equator. Fading rate for each C.W. record is obtained by counting the number of maxima occurring per minute. To keep consistency only fluctuations greater than 10% of the average fading amplitude were considered, an approach similar to that of Dagg⁵ in connection with star scintillation analysis. As a preliminary study, all the overhead observations were classified into 5 groups with 0-2, 2-4, etc., spread-F indices. C.W. fading rates associated with these class ranges are averaged and shown in Table I. Peculiarly, this table does not indicate any systematic dependence of the fading rate on the spread-F index except that there is a three to four-fold increase during spread-F conditions as against calm conditions.

TABLE I

Sl. No.	Spread-F index range	Average rate of fading, peaks/min.
1	0-2	13.9
2	2-4	34.7
3	4-6	44.8
4	6-8	32.8
5	8-10	42.3

This result, as such, does not encourage the use of C.W. fading rate as a measure of the intensity of the irregularity, but suggests a possible time shift in the occurrences, of a certain intensity, at the overhead point and the effective region of the Ionosphere involved in the C.W. transmissions used. In order to verify this possibility continuous C.W. recording together with overhead pulse observations at closer intervals are being considered. One of the obvious causes of this time shift is the movement of the irregularities. If due account is taken of this time shift it seems likely that a fairly linear increase of the fading rate with increased spread-F activity may be obtained. Early results have already indicated this time shift. A complete investigation into this and other aspects of fading will be published elsewhere shortly.

The authors wish to acknowledge with thanks the financial support of these investigations by the Council of Scientific and Industrial Research, India.

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June 28, 1960. PANT.

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ON THE USE OF MUREXIDE AS INDICATOR IN ESTIMATION OF CALCIUM USING ETHYLENEDIAMINETETRAACETIC ACID

MUREXIDE or ammonium purpurate is an important metal-ion indicator used extensively for the titrimetric determination of Ca^{++} by chelating agents such as ethylenediaminetetraacetic acid (EDTA).¹⁻³ This method of estimation of Ca^{++} is more simple and accurate, and less time consuming than the familiar oxalate method. In the complexometric titration using EDTA, the end-point is indicated by the change, to violet, of orange-red colour of calcium purpurate in highly ammoniacal or alkaline solutions. The necessity of the high alkaline or ammoniacal media ($\text{pH} > 11$) in these titrations, was discussed elsewhere.^{4,5} It may, however, be pointed out that the indicator, viz., murexide undergoes rapid irreversible decomposition at high $\text{pH} > 9$ leading to the decolourisation of the characteristic orange-red colour. This sets a limitation to the titration in the sense that the estimation should be completed within a short interval of time before the colour decays completely. As a part of the research programme on the kinetics of decomposition of murexide in alkaline solutions, we investigated spectrophotometrically the effect of different solvents on the corresponding reaction rate. During these studies a few interesting observations were recorded which appeared to be of marked analytical importance; these are reported in the present communication.

B.D.H. sample of murexide was purified by the method of Davidson.⁶ Ethyl alcohol and acetone were purified by distillation using conventional methods. Beckman DU spectrophotometer

equipped with dual thermospacer set was used. The experiments were carried out at $30^\circ \pm 40.1^\circ \text{C}$.

The kinetics of the decomposition of murexide were followed by noting the change with time of optical density of murexide solutions at $\lambda = 340$ and $545 \text{ m}\mu$ where murexide showed absorption maxima and where the absorption of the solvent was negligible. The analysis of the data indicated that the reaction under investigation obeyed a first order law. Table I

TABLE I

Rate constants of the decomposition of murexide in different solvents

% of organic solvent by weight	Ethyl alcohol		Acetone	
	Dielectric constant	Rate constant $K' \times 10$	Dielectric constant	Rate constant $K' \times 10$
0	76.73	2.84	76.73	2.86
5	74.78	2.24	74.05	2.47
10	72.82	1.94	71.37	2.09
15	69.43	1.74	68.36	1.85
20	66.03	1.47	65.34	1.69
25	63.55	1.28	62.41	1.58

gives the values of the rate constants K' in solvent water mixtures of different composition. Column 2 in Table I gives the values of dielectric constant of the solvent mixtures obtained from the data of Akerlof.⁷ It is seen that K' decreased appreciably with a decrease in D . Thus K' was 2.24×10^{-1} and 1.28×10^{-1} at $D = 74.8$ and 63.6 respectively. These data give linear plots $\ln K'$ vs. $1/D$ in accord with the following equation due to Bronsted-Christiansen and Scatchard⁸ :—

$$\ln K'_{\mu=0} = \ln K'_{\mu=\infty} - \frac{Z_A Z_B e^2}{DkT\epsilon}$$

This enables one to obtain fundamental information regarding the mechanism of the decomposition of murexide which, however, does not form the subject-matter of the present note.

Further Table I shows that murexide is more stable in water-ethyl alcohol mixture (25%) suggesting a modification in the Swarzenbach's procedure for estimation of Ca^{++} ; the use of murexide in alcohol-water mixture for estimation of Ca^{++} with EDTA renders the observations to be made with greater ease and accuracy as actually found by authors.

Authors' thanks are due to the Director, National Sugar Institute, for permission to publish this note and to the Ministry of Scientific

Research and Cultural Affairs for a maintenance grant to one of us. (R. K. C.).

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RELAXATION TIMES OF SOME DIPOLAR LIQUID MIXTURES AT 3 cm.

IN continuation of the author's work on dielectric relaxation in dilute solutions, the concentration variation method due to Gopal Krishna¹ has been extended to determine relaxation times of mixtures of dipolar liquids in benzene at 3 cm. In order to do so, the author has kept in view Schallamach's² suggestion that the elementary process in dielectric relaxation cannot be directly connected with individual molecules but is a disturbance of an appreciable region in the liquid and consequently for such a mixture only one relaxation time is involved. Moreover for simple polar molecules in dilute solution, distribution of relaxation times is also not to be expected. Six solutions of increasing concentrations were made by mixing equal volumes of the two components of dipolar liquids in benzene. The dielectric constants and loss-tangents of the respective dilute solutions were determined by standard short-circuited line technique of Von Hippel and Roberts³ described earlier. Microwaves generated by Reflex Klystron (CV 129) were reflected from a silver short circuit after travelling through a wave-guide system, and measurement of the shift of minimum field position and width at twice minimum on the resulting standing wave pattern enabled the evaluation of K and $\tan \delta$. Finally τ was calculated for the mixture according to the method of Gopal Krishna.¹

The experimental results recorded in Table I show that for every pair of dipolar liquids the relaxation time of the mixture is the average

of the two individual relaxation times. The author is thankful to Dr. P. N. Sharma, Professor, Lucknow University, for guidance. Full details will be published elsewhere.

TABLE I

Relaxation times of some liquid mixtures in benzene

(Freq. 9516, MC: Temp. 30° C.)

Polar liquids	Relaxation time $\times 10^{12}$ sec.	Liquid mixtures	Relaxation time $\times 10^{12}$ sec.
1 Acetone	2.8	1 Ethyl butyl ketone + acetone	4.7
2 Ethyl butyl ketone	6.6	2 Ethyl butyl ketone + benzylamine	5.5
3 Benzyl alcohol	6.7	3 Benzylamine + benzyl alcohol	5.7
4 Benzylamine	3.6	4 Benzyl alcohol + ethyl butyl ketone	6.6
		5 Acetone + benzylamine	3.1

Physics Department,
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ELECTRO-OSMOSIS IN CHARGED MEMBRANES

THE effects of concentration of external electrolyte solution and of current density on the electro-osmotic transport of liquid through a cross-linked phenol sulphonate membrane at 30° C. have been studied using the technique described elsewhere.^{1,2} The results presented in Fig. 1 are explained on the basis of a model for ion-exchange resins suggested by Kitchener.³

Water transport (ml. F⁻¹) through the membrane in equilibrium with 1.0, 0.5 or 0.1 N NaCl solution is independent of current density, although the volume of flow is raised when the resin is in contact with a more dilute solution. This can be ascribed to decrease in the interstitial molality of the gegen ion (m_g) and

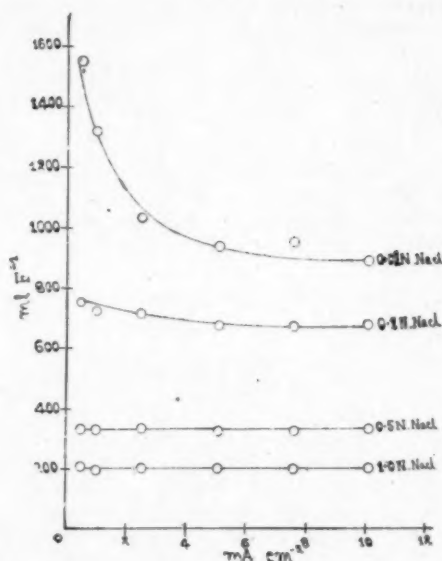


FIG. 1

of the neben ion (m_n) (cf. Table I) and of consequential increase in the transport number

TABLE I

NaCl external solution	Interstitial molality g. ion per 1,000 g. of interstitial water	
	m_g	m_n
1.00 N	2.047	0.707
0.50 N	1.697	0.309
0.10 N	1.406	0.034
0.01 N	1.301	0.005

of the gegen ion. The nature of the curve for 0.01 N external solution is the same as the one presented previously.⁴

In concentrated electrolyte solutions (< 0.1 N), ion-exchange resins lose their permselectivity.⁵ Resin pores get filled uniformly with gegen and neben ions. The gegen ion molality m_i , for any randomly chosen pore i , is nearly equal to the observed m_g value. The experimental values (Table I) are obviously averages for all the n pores in the membrane and may be written as -

$$m_g = \frac{\sum m_i}{n} \quad (i = 1, 2, 3, \dots, n)$$

In fact the resin loses its character and becomes similar to a concentrated electrolyte solution,

So, all the ions participate in transport giving a quantity of electro-osmotic flow which is independent of current density. But in more dilute solutions (0.01 N) the neben ions are excluded from the resin phase and most of the gegen ions are concentrated along the polymer chains.⁶ Further there are likely to be uncharged and slightly charged pores.⁷ This leads to a non-uniform distribution of ions in each pore of the resin ($m_1 \neq m_2$); i.e., the composition of the resin solution changes from point to point.

Application of high currents may transport the solvent in the centre of the pores without mobilising the liquid layers near the walls of the pores. This produces a limiting value for liquid transport. But at low currents, uncharged or slightly charged pores (very low m_1 values) may become electro-osmotically active and the whole liquid phase in the pores may become mobile. Under these conditions larger quantities of solvent are transported. It is significant that the rise in the curve is almost asymptotic to ml. F^{-1} axis. It is probably so when electro-osmotic flow of liquid is confined to uncharged or slightly charged pores.

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University of Madras,
Guindy, Madras-25,
January 28, 1960.

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ELECTRONIC PULSE TECHNIQUE AND THE MUSICAL SCALE

THE difficulties of modulation on keyboard type of musical instruments were responsible for the adoption of the Tempered scale by European countries. Difficulties of tuning the instruments of accompaniment, whenever the key-note is changed to suit the voice of an individual singer led to the adoption of the Tempered scale Harmonium in India.

Physicists and musicians naturally think of the structure of the scale in terms of the major

tone, minor tone and semi-tone or express the scale in terms of the intervals of the notes of the scale with respect to the key-note. This way of regarding the structure of the scale, naturally gives an impression that these ratios are rather complex and incapable of simpler derivation.

If however we take the frequency of $G (= 360 \text{ c/s})$ as a given note then the following interesting facts follow:—

(G)	= G	..... 360
(G) - 1/3 (G)	= C	..... 240
(G) + 1/3 (G)	= C'	..... 480
(G) - 1/4 (G)	= D	..... 270
(G) + 1/4 (G)	= B	..... 450
(G) - 1/5 (G)	= Eb	..... 288
(G) - 1/6 (G)	= E	..... 300
(G) - 1/9 (G)	= F	..... 320
(G) + 1/9 (G)	= A	..... 400 etc.

In order to realise the notes related in this manner, pulse technique and counter type of divider-circuits are used and these notes of the scale are derived from one original note which can be varied within limits.

A model of such a musical standard is already built in this laboratory and even though it covers only one octave of the scale, at present it is enough to demonstrate the underlying principles of operation.

A comprehensive paper giving the circuit details and its operation is under preparation and will soon be published.

Physics Department,
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B. B. DESHPANDE.

SEPARATION OF URANIUM AND RARE EARTHS

URANIUM has been separated from Cerite earths successfully by adopting the following procedure.

A bed of Amberlite IR 120, 10 cm. by 1 sq. cm. (circular) is first washed with 100 ml. of 2% sodium chloride solution and then made acid by running 200 ml. of 5% hydrochloric acid after running 300 ml. water. The column is finally washed with water (300 ml.). A mixture of the nitrates of the cerite earths and of uranium in 100 ml. water is then let through the bed at a flow rate of 3 ml. per minute. On elution with 1 N HCl it has been found that all the uranium may be recovered in the first 350 ml. of the liquid. The rare earths may then be recovered employing 1.68 N HCl for elution, about 600 ml. of which are required. The following mixtures have been tried,

	Uranium oxide in gm.	Rare earth oxides in gm.	Ratio
(a)	0.0342	0.0120	2.8 : 1
(b)	0.0228	0.0064	1 : 4.2
(c)	0.0114	0.0482	1 : 4.2
(d)	0.0120	0.1446	1 : 12

If however the ratio of rare earths is high as in (d) the latter pierces through in small quantities. In this case if the strength of the eluent is reduced to 0.5 N HCl this break through is avoided, but elution takes larger volume requiring about 2,000 ml. for the complete removal of uranium and 1,200 ml. (1.68 N) for rare earths. Further work is in progress.

My thanks are due to Prof. Bh. S. V. Raghava Rao for continued interest and guidance.

Inorganic Chem. Lab., D. PURUSHOTTAM.
Andhra University,
Waltair, December 2, 1959.

UTILISATION OF FUNGAL PECTOLYSIS

WHILE searching for pectolytic (retting) fungi, several fungi from the barky portions of jute fibre were isolated by standard plating method. These were grown on potato-dextrose-agar slant culture and then further plated twice for isolation of the cultures in more or less pure condition. Of the numerous fungi obtained, a few were selected for study after preliminary trial as regards growth on pectin-agar medium of pH 5 containing ammonium sulphate as source of nitrogen and pectin as the sole source of carbon. The selected fungi were next grown on pectin-ammonium sulphate liquid medium of pH 5. The spore-free culture broth was tested for pectolytic activity by the modified cup and plate method of pectic enzyme assay of Reid.¹ Out of the selected fungi, a black-spored variety (identified) showed maximum pectolytic activity. In consideration of its high activity, this was chosen for further study.

Chromatographic studies with the filtered culture broth acting on pure pectin solutions showed the hydrolysis of the same to galacturonic acid.

The enzyme preparation from the culture broth was done by precipitation of the cold water extract of the wheat bran culture with alcohol. After two precipitations, the residue finally obtained by centrifuging was taken in a small volume of water. By cup and plate method of assay, this was found to possess pronounced pectolytic activity.

The culture broth was tested for cellulolytic activity on pure cotton and jute alpha-cellulose. But no hydrolysis to sugar or reduction in weight was detectable. The chromatogram also showed no spot of reducing sugars. The same was true for holo-cellulose from jute. But in case of jute hemicellulose, there were a few intermediate oligosaccharides and xylose as the breakdown product. On quantitative determination of hemicellulose breakdown, a 25% hydrolysis in terms of xylose was found at the end of 24 hours. Xylose was estimated by the method of Somogyi² in the hourly drawn culture broth-treated samples of hemicellulose solution (sodium salt of hemicellulose) and suspension (acidic hemicellulose). The filtered culture broth neither had any action on filter paper strip and powder nor the fungus could support growth on media having filter paper strips as carbon source. The culture broth had no action on reactive cellulose, e.g., cellulose swelled with phosphoric acid.

Laboratory-scale trials were done with small strips of green and dry jute barks, sprayed with 1% ammonium sulphate, containing traces of magnesium chloride and manganese sulphate, to keep the barks moist enough to support growth, to which a small quantity of the fungus grown on wheat bran was sprayed and allowed to grow for 120 hours. Daily visual inspection showed that these were appreciably loosened after 96 hours and the pH fell.

To assess the retting property, the fungus was tried for loosening the barky portions of jute fibre. Moistening was done in the same manner as above, placed in a bin for 120 hours. After usual mill procedure these were made into yarns.

Fungus-treated samples had much better appearance with a very few specks and barky tissues in comparison to the control. There was no significant change of quality ratio nor any deterioration in spinning performance. Yarn uniformly was also not significantly different in respect of treated fibres. Further detailed work is in progress.

Thanks are due to Dr. P. B. Sarkar, Director, for his keen interest in the work and for his constant encouragement.

Tech. Res. Lab., ASIT RANJAN GUHA ROY.
Calcutta, April 27, 1960.

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PRELIMINARY OBSERVATIONS ON THE POLLUTION OF THE RIVER KALI CAUSED BY THE EFFLUENTS OF INDUSTRIAL WASTES

DUE to a steady rise in the industries of India and a slow increase in waste water treatment plants, increasing use is being made of rivers as sources of disposal of untreated industrial wastes. So far in our country the problem of river pollution has not reached alarming limits, nevertheless, if no suitable measures are taken at this stage, it is bound to cause an adverse effect on our fishery resources. Many instances of heavy fish mortality caused by the effluents of industrial wastes have been reported earlier,¹⁻³ and in most cases, it is

At Bulandshahr, many picturesque and rather sentimental descriptions were furnished by the fishermen and the general public about the fish mortality and the existing state of affairs. Our enquiries with the sugar mill authorities revealed that there are more than half a dozen factories and mills discharging their wastes in this river. These include distilleries, textile mills and other factories of Modinagar, Meerut District and many sugar mills situated within an area of about 70 sq. miles. Apparently the river is being subjected to a collective pollution and is made to carry a heavy load of unstable organic and toxic substances. A summary of the physico-chemical analysis of the Bulandshahr sugar mill effluent is given in Table I.

TABLE I

Colour	Temp. °C.	Turbidity p.p.m.	Odour	pH	Total solids p.p.m.	D.O. p.p.m.	B.O.D. 5 days 37° C.	Sp. Conductivity mhos	Resin soaps	Sulphides	Free Chlorine	Mercaptans
Black	33-38	55-140	Un- pleasant	5.8-6	1180	Nil	400 p.p.m.	7.98×10^{-4}	Absent	Absent	Absent	Absent

believed that a regular contamination of our waterways is likely to make them incapable of supporting animal or plant life.^{4,5}

The River Kali is a small perennial river of the western U.P. It flows almost midway between the Rivers Ganga and Jamuna, and about 50 miles upstream of Kanpur meets the River Ganga. Not very long ago, it formed an important source of fishery of the western U.P., but for the last few years numerous reports of heavy fish mortality have been received from time to time and there is a general feeling in this part of the country that the fish resources of this river are rapidly on the decline. Our observations on this river in March at Bulandshahr where the effluent of an important sugar mill is being discharged revealed the problem to be more acute than we had anticipated. The conditions prevalent in the river at that place seemed far from being satisfactory. The colour of the river water was markedly brown with a turbidity 55-70 p.p.m. and in close vicinity of the outfall of the effluent, it gave a strong unpleasant odour. The pH ranged from 6.2 to 7.7 within one mile upstream of the outfall; D.O., 1.5 to 4 p.p.m. and B.O.D., on an average 10 p.p.m.

According to the standards prescribed by the Royal Commission,⁶ this river falls under the lowest category and obviously demands immediate abatements,

It is evident from Table I that the quality of waste is not of a desirable standard. However, this particular effluent does not seem to contain any toxic substances. It increases the B.O.D. load which depletes a great deal of dissolved oxygen in the river water. The total discharge of the effluent depends on the quantity of cane crushed and in most of the sugar mills of U.P., it roughly amounts to 650 gallons per ton of cane crushed.⁷

Almost all sugar mills of the western U.P. operate for about 5 to 6 months in a year (November-April) and according to the figures given by the authorities of the Bulandshahr sugar mill, the total quantity of cane crushed in their mill from 2nd November 1959 to 14th March 1960 amounts to 1,38,892 tons.

Reports from various sources suggest that the fish mortality in the river is intermittent and can occur at any time of the year. It is, however, fairly regular and heavy during the early monsoons. This period does not coincide with the working season of sugar mills, but since many other factories operate during this season, it seems likely that wastes of a highly toxic nature are released from somewhere during the early monsoons. We are told that in this season even the cattle refuse to drink water of that river.

Many village folks living in the neighbourhood of the River Kali show great emotional

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attachments with this river and consider it as their national heritage. They continue to utilize its water for their domestic needs at a grave risk. Undoubtedly the problem of pollution in this river is acute and demands a detailed investigation, otherwise, it is feared that like the notoriously polluted River Irwell of Lancashire, England,⁸ this small river too, once known for its many activities will soon become dead.

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A METHOD FOR TRACING THE COMPLETE TRACHEAL SYSTEM IN AGROMYZID LARVÆ

The information about the technique of tracing the detailed tracheal system of insect larvæ is very meagre. Various workers have reported several methods to study the tracheal system of other groups of insects and have claimed the success of their particular method. But it so seems that a particular method holds good for a particular insect or a group of insects. For tracing the complete tracheal system in the maggots of the family agromyzidae (Diptera) we tried the techniques described by Kustar and Kimber (1934), Roonwal (1935) and Puri (1954) for aquatic insect larvæ, white fly nymphs, and sugarcane borers, respectively. None of these techniques proved satisfactory in case of the maggots as far as tracing of finer tracheoles was concerned.

Out of the several methods tried we found the following method most satisfactory to trace out the complete tracheal system of Agromyzid larva :

MATERIALS

1. Sudan III solution prepared in 70% alcohol with a few drops of hydrochloric acid and glycerine. It was kept for 12 hours and then filtered.

2. Modified Lectochloral-Berlese's fluid prepared with the help of the following :

Distilled water	..	..	25 c.c.
Gum Arabic	..	..	15 gm.
Chloral Hydrate	..	..	160 gm.
Glucose syrup	..	..	10 c.c.
Glacial acetic acid	..	..	5 c.c.
Lactic acid	..	..	2 c.c.
Formalin	..	..	5 c.c.

Gum Arabic was dissolved in distilled water; glucose syrup was added and then chloral hydrate to saturation. Glacial acetic acid, lactic acid and formalin were added just before using the fluid.

TECHNIQUE

The living maggots were dipped in the solution of Sudan III for about 20 minutes. As a result of this treatment the maggots become somewhat clear. The maggots are then transferred to distilled water to wash off the solution. Then they are mounted in the modified Lectochloral-Berlese's fluid on a clean slide; slide is warmed gently over a mild flame for about 2 minutes. After about two hours the tracheæ and fine tracheoles become clearly visible and the whole tracheal system can be drawn with the help of the camera lucida. The slide thus prepared can be kept for a few days but no permanent mount can be made of the tracheal system.

Dept. of Agric., N. S. AGRAWAL.
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BIONOMICS OF AZYGOPHLEPS SCALARIS FABR. (LEPIDOPTERA : COSSIDÆ)—STEM- AND ROOT-BORER OF DAINCHA (SESBANIA SPP.) IN THE UTTAR PRADESH

FLETCHER (1919) reported that *Azygophleps scalaris* Fabr. causes severe damage to *Agathi* (*Sesbania grandiflora*) and *Jainti* (*S. ægyptica*) in South India and minor damage to *Daincha*

(*S. aculeata*) in other parts of India. Lefroy (1913) recorded its attack on both *Agathi* and *Jainti* in Bengal and Madras. Ayyar (1940) reported this pest from *Agathi* and *Daincha*. This borer, however, has not been reported from U.P., so far, although a good number of species of *Daincha* (*Sesbania* spp.) are being grown in various parts of the State for green manuring as well as for raising the seeds. We observed its attack on *Daincha* for the first time at Kanpur in the year 1958. Studies on the bionomics of this pest are undertaken which lead us to believe that *A. scalaris* is a serious pest of *S. aculeata*, *S. macrocarpa*, *S. sericea* and *S. speciosa* in U.P. Results of some of the observations during the year 1958-59 are summarised below:

LIFE-HISTORY

The female moth lays pale-yellow eggs in mass numbering about 400-500 in the first and second week of July. They are cemented to the leaves of the host plant, viz., *Daincha*. They

larva takes 50-80 days to become full-grown. Pupation takes place inside the stem generally near the base of stem in partitioned chamber after cutting an exit hole. The moth emerges out by pushing through the operculum of the exit hole on the epidermis.

There appears to be only one generation in a year. On the onset of winter the immature larvæ die out and full-grown larvæ hibernates in the left-over stumps of the plants. The over-wintering larvæ pupate in the second week of June in the following year and after about fortnight the moths emerge.

DAMAGE

A single larva enters from the growing point down to the main stem. Near the point of entry of the larva the stem becomes knotty and the plant becomes weak so much so that it bends down in an elbow-like manner from this particular point possibly due to wind jerks (Fig. 2). The larva continues tunnelling down the main



FIGS. 1-3. Fig. 1. Caterpillars of *A. scalaris* Fabr. in various stages of development. Fig. 2. Stem of *Daincha* bent in an elbow-like manner and the other one split open to show the frass and damage of the borer. Fig. 3. Showing larva and its tunnels up to the tip of the main root. Tunnels are full of frass.

hatch out in 5-8 days. The newly hatched caterpillars are creamy white with deep-brown head and measure 1.1-1.3 mm. They suspend themselves in the air on silken threads spun by them and are blown by wind to other plants. A single caterpillar enters from the growing point and tunnels down the main stem. The larval and pupal period (70-100 days) is entirely passed inside the stem of *Daincha*. The full-grown larva is long and slender measuring 2.6-3 inches, pale-white in colour with a large prothoracic reddish-brown plate (Fig. 1). The

stem and bite holes to the outside at intervals. It practically eats away the contents of the stem, leaving the epidermis only. The tunnel is filled with frass and faeces (Fig. 2). The larva bores down as far as the tip of the main root before it pupates (Fig. 3). The frass from inside is thrown out through the holes from time to time and is found accumulated all around the base of the attacked plant. A deposit of the frass around the plant is a clear evidence of the presence of a borer in the plant. The borer has also been observed to tunnel up and down

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leaving only the epidermis intact at certain points and as such the plant becomes so weak that it breaks off with the slightest jerk at the weak points.

In a study in randomised blocks on the incidence of attack on four species of *Daincha*, viz., *S. aculeata*, *S. macrocarpa*, *S. sericea* and *S. speciosa* grown at the Government Research Farm, Kanpur, it was found that 15% plants were attacked in the first variety; 18% in the second, 10% in the third and 35% in the fourth. The results were significant. The attacked plants present a very sickly appearance and the apices of the plants dry out. Ultimately such plants are killed without bearing any flowers and seeds and a great loss is incurred by the farmer.

As mentioned above the caterpillar before pupation remains in the lowermost part of the stem or in the root and over-winters there in larval stage, uprooting the stumps immediately after harvesting and burning them may prove an effective means of control.

Sincere thanks are due to Dr. U. S. Sharga, Head of the Department, and to Dr. R. R. Agrawal, Agricultural Chemist to Government U.P. and Incharge Government Research Farm, Kanpur, for providing facilities for this study. We are grateful to Dr. T. Nishida, Visiting Professor of Entomology from the University of Hawaii, U.S.A., for taking photographs of the material.

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H. S. AGRAWAL.

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A NOTE ON THE NATURAL CONTROL OF THE SUGARCANE MITE *OLIGONYCHUS INDICUS* (HIRST)

Oligonychus indicus (Hirst) is a widely distributed species, sometimes causing serious injury to sugarcane leaves in Northern India. Rahman and Sapra¹ have studied in some detail the biology and bionomics of the sugarcane mite in the Punjab. The larvae and the females of the mite which cause the damage, feed on the underside of leaves and produce characteristic reddish patches covered with web. The identity of the species of mites attacking sugarcane and

other alternate hosts are mentioned in a note by Khan and Murthy.²

The attack of the mites was first noticed in an isolated field in the top block of the Agronomy Division, I.A.R.I., New Delhi, during the second week of June 1958. The pest had apparently migrated from nearby wild grasses and the dispersal of the insect had been facilitated by strong winds. The mite population in the field steadily increased and by the last week of June, the pest had multiplied to such an extent that most of the old leaves of the attacked plants had completely turned reddish. The warm and dry conditions during the month of June coupled with the insufficient irrigation which this particular field had received, seem to have created optimum conditions for the rapid multiplication of the mites within a short time.

A close examination of the attacked leaves, however, revealed the presence of a minute coccinellid beetle (*Stethorus pauperculus* Weise) which had followed its host and was found actively feeding on the different stages of the mite. It was rather interesting to watch the progress of natural control of the pest by the beneficial beetle. The adults and grubs of *S. pauperculus* which were first noticed in the field in the third week of June, increased to enormous numbers in a short time in the presence of abundant food supply. By the first week of July, the sugarcane crop showed signs of revival and entire field was almost free from mites. Observations on the population of the predator were made in the second week of July. The average number of live and empty pupae of *Stethorus* per leaf was 20, the highest number being 36. The performance of the beneficial predator (*S. pauperculus*) was repeated in August 1958, and again in September 1959, when some imported hybrids of sorghum in the Botany Division were found heavily attacked by *Oligonychus*. The mites had already multiplied and inflicted damage to the foliage prior to the arrival of the predator on the scene. Every time the predatory beetle which had closely followed its host, built up a large population within a short time and practically wiped out the entire mite colony from these fields. A close watch was kept on the incidence of the predatory beetle in the field throughout the season. It was interesting to find that the predator maintained a low population through the season on some alternate hosts like *Tetranychus equitorius* on bhindi and lettuce, and on *Eutetranychus banksiae* on castor. Kapur³ has reported *S. pauperculus* as a predator on *Paratetranychus*

on sorghum in South India and on mites on various crops, such as castor, apple, plantain, in Northern India.

The above observations are recorded to show the important role played by natural enemies in checking the outbreaks of crop pests and to emphasise the need to acquire a more profound knowledge of the biological problems of the pest in order to make a rational use of the valuable aids placed in the hands of the entomologists by the chemists.

Our grateful thanks are due to Dr. E. S. Narayanan, Head of the Division of Entomology, and to Dr. B. P. Pal, Director, I.A.R.I., for their interest in this work. Thanks are also due to Dr. A. P. Kapur, Zoological Survey of India, for the identification of the predaceous beetle, and to Miss N. Khot, Division of Entomology, for the determination of the mites.

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ON THE BIOLOGY OF THE ONION THRIPS, *THRIPS TABACI* (LIND.) (THYSANOPTERA: THRIPIDÆ)

THE onion thrips, *Thrips tabaci*, is a cosmopolitan insect and has been very destructive to onion and garlic crops in Bihar during the last five or six years. In view of the serious damage sustained by the crops, detailed studies on the biology and control of the thrips were carried out during the years 1957-59 for developing effective measures of control.

The stock culture of the onion thrips was maintained on potted onion seedlings in the laboratory. The rearing container which was a glass trough (10" dia. × 4" deep) was provided with a soil-layer of 4" at the bottom and four onion plants planted at equal distances inside it (Fig. 1). A square cork-sheet with four circular holes cut through was used as a lid allowing the four plants to pass through, one plant being enclosed at each hole. Four glass vials with open ends (2" dia. and 6" high) were inserted inside the holes of the cork-sheet enclosing the protruding plants. The tops of the glass vials were closed with cellophane sheet with the help of a rubber band while the lower end of the vial was firmly fixed on the edge

of the cork-sheet holes by means of cotton wads. The adult thrips were introduced inside the vials by means of a wetted camel hair brush. As soon as ovipositions were observed, the number

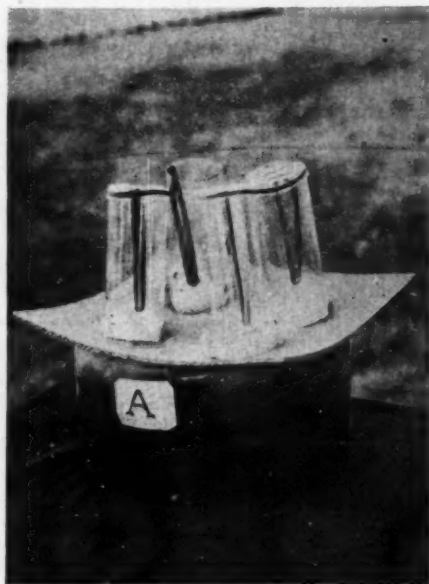


FIG. 1

of eggs laid by a female thrips each day was counted and recorded. On hatching of eggs, the larvæ were isolated and reared on onion leaves inside petri-dishes. For evaluating the efficacy of soil factors (N, P, K and pH) on thrips infestation, soil samples were collected from the infested onion fields in different localities. They were drawn from a depth of 4" in five different spots of the infested field. The soil samples were analysed in the Chemical Laboratory and the percentages of nitrogen, phosphate, potash and pH were estimated. Before drawing soil samples, the thrips infestation of each field was estimated and the correlation between the soil factors and the thrips infestation was studied.

The onion thrips were found throughout the year on some hosts or the other in Bihar. The maximum activities of the thrips were observed on the "set" and the "seedling onions" during October to April. A restricted breeding of the thrips was found on cotton, brinjal, bottle gourd, bhindi and sunn-hemp during June to September. In the laboratory nine generations of the thrips were recorded during November to March. The thrips were found to pass

life-cycle during D (13-88 days) the temperature and 78-61% the average relative humidity clusters in and the temperature averaged 1 of the thrips typical thrips ing and d infestation growth, w The high plant) was with high and potash slightly a infestation, under clay N (0-065% and potash

through four stages (egg, larva, pre-pupa and pupa) before becoming adult (Fig. 2). The

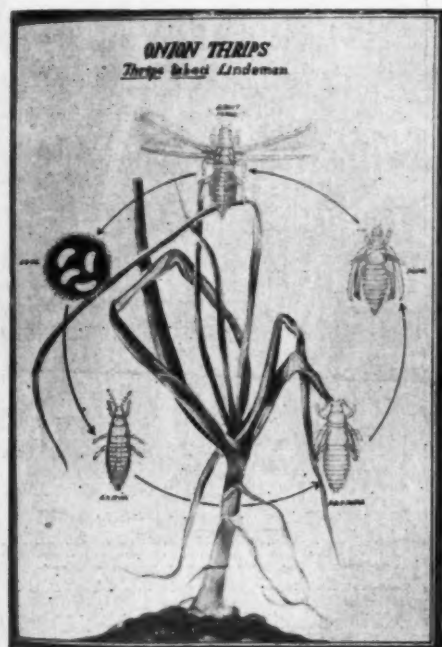


FIG. 2

life-cycle duration was the highest (23.36 days) during December, while it was the shortest (13.88 days) during April. During December the temperature and humidity averaged 17.50° C. and 78.62% respectively, while during April, the average temperature was 30.84° C. and relative humidity 47.60%. The eggs were laid in clusters inside the epidermal layer of the leaves and the total number of eggs laid by a female averaged 15.9. The longevity of the females averaged 18.71 days. Both the adults and larvae of the thrips usually feed on the plant-sap. The typical thrips-injury usually results in yellowing and dropping of leaves. In case of heavy infestation, the plants usually exhibit stunted growth, white blotching and low yield.

The highest thrips infestation (31.56 per plant) was observed in fields of sandy loam soil with high N (0.095%), low levels of phosphorus and potash (0.01 and 0.006% respectively), and slightly acidic soil reaction (pH 6.8). Low infestation, on the other hand, was recorded under clay soil type with low percentage of N (0.065%), high percentages of phosphorus and potash (0.013 and 0.007%) and acidic soil

reaction (pH 6.4). Weekly irrigations in micro-plots (3' x 5') exhibited low thrips infestation (15.30) and high yield, while fortnightly irrigations brought about low infestation (17.80) and also low yield. Fortnightly sprays with Folidol (0.02%) provided the best protection against the thrips. The treatment BHC (0.125%) gave similar response but exhibited low residual toxicity. The second best treatments were Aldrin (0.25%), Dieldrin (0.25%) and Endrin (0.25%). Treatments DDT (0.125%) and Diazinon (0.025%) were found to be quite ineffective.

The observations of Ramchandran (1950), Rahman and Batra (1944) and Mac Gill (1927) on the fecundity and life-cycle of the thrips agree with the findings of this paper. High residual toxicity of Aldrin and Dieldrin as reported in the paper confirm the findings of Olalquiaga (1953), Richardson (1953), Peairs and Davidson (1956) and Gaines *et al.* (1952). The low toxic reaction of DDT (0.125%) finds support in the claims of Richardson (1957) who made similar observations. The superiority of Folidol treatment confirms the findings of Jack *et al.* (1954), Lall and Verma (1959) who obtained satisfactory control of thrips with Folidol.

The low infestation under clay soil may be explained by the fact that high levels of phosphate and potash and low level of nitrogen might have produced hard tissue in the plants which enabled them to escape thrips injury. The delayed maturity as observed in sandy loam soil with high nitrogen level and low levels of potash and phosphate seem to account for high infestation. Similar observations regarding high infestation in sandy loam soil were made by Mac Gill (1931). The low infestation in the treatment with high frequency of irrigation may be due to the adverse effect brought about by irrigations on the thrips population inside the soil.

The authors wish to express their sense of gratitude to Sri. R. S. Roy, Principal, Bihar Agricultural College, Sabour, for providing the necessary facilities in the Post-graduate Laboratory for carrying out the investigations.

Division of Entomology, B. S. LALL.
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AVAILABLE ZINC STATUS OF SOME INDIAN SOILS

As information on the available zinc status of Indian soils is scanty, its content in some of the representative soils is reported here. The bio-assay method of Mulder¹ as used by Nicholas² has been employed with certain modifications.

The content of available and total zinc in different soils					
No.	Location	Soil group	Total Zn (p.p.m.)	Available Zn (p.p.m.)	Per cent. available Zn
1	I.A.R.I., New Delhi	Alluvial	33.7	4.5	13.3
2	Pusa (Bihar)	do.	37.5	6.0	16.0
3	Puri (Orissa)	do.	68.0	6.3	9.2
4	Indore (M.P.)	Black	76.0	1.1	1.4
5	Angul (Orissa)	do.	69.0	3.8	5.5
6	Bhubaneswar (Orissa)	Laterite	24.0	1.2	5.0
7	Puri (Orissa)	do.	30.0	1.2	4.0
8	Phulbani (Orissa)	Red	74.3	7.0	9.4

Although the total zinc content of black soils is perhaps the highest among the soils reported, their available zinc content is low and would reflect conditions of acute deficiency according to the classification used by Donald *et al.*³ These soils were, on the other hand, quite rich in their available copper content.⁴ The values for available zinc for alluvial soils fall on the borderline between non-deficient and deficient groups of soils according to Donald *et al.*³ These may or may not, therefore, respond to applications of zinc. The data on the available zinc and copper (unpublished) status of alluvial soil of Puri support the general observations of the high

fertility status of these soils. The red soil from Phulbani has shown high values for both available and total zinc content. Although red soils are generally leached soils, the high status of this soil in respect of zinc may be due to its virgin nature.

The authors are grateful to Dr. B. P. Pal, Director and Dr. R. V. Tamhane, Head of the Division of Chemistry of this Institute, for their interest in the progress of this work.

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ON THE ABSENCE OF PELVIC FINS IN CIRRHINA MRIGALA (HAM.) AND ANAL FIN IN CATLA CATLA (HAM.)

BRINDLEY¹ has recorded a White Bream, *Abramis blicca*, in which the ventral fins were absent. Eigenmann and Cox² and Willey³ have reported the absence of ventral fins in a yellow cat-fish *Ameiurus natalis* and in a specimen of *Amia calva* respectively. Hora⁴ has observed the absence of pelvic and pectoral fins in a few fishes belonging to different families. The absence of paired fins either partially or totally has thus been reported by various workers. The present communication records the total absence of pelvic fins in an adult specimen of *Cirrhina mrigala* and anal fin in *Catla catla*.

The specimen of *Cirrhina mrigala*, which weighed 1,792 gm. and measured 523 mm. in total length, was obtained from the local fish market at Jama Masjid. The fish appeared quite normal but for the absence of pelvic fins. The place of origin of the fins did not show any scar externally and it was covered with normal scales. A dissection of the fish in the pelvic region revealed no trace of pelvic girdle and maceration of muscle tissue also did not show the presence of any bony element.

The specimen of *Catla catla*, weighing 6,048 gm. and measuring 610 mm. in total length, was collected from one of the tanks in Delhi. The fish was normal in appearance except for

the absence of pelvic fins. The fish was collected from the same region, located.

The authors are grateful to Dr. B. P. Pal, Director and Dr. R. V. Tamhane, Head of the Division of Chemistry of this Institute, for their interest in the progress of this work.

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May 14, 1960.

* Present address: Botany Division, I.A.R.I., New Delhi.

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from the absence of anal fin. There was no indication of external injury at the place of origin of anal fin which region was completely covered with scales. On examination of the anal fin region, a proximal piece of radial bone was located. It was situated almost parallel to the axis of the vertebral column on the haemal spines of the fifth to seventh caudal vertebrae or 30th to 32nd in series. The piece of bone was triangular in outline and was directed anteriorly. The muscle tissue from this region was macerated and was examined and no trace of any other bony element was observed.

Different causes have been attributed to explain such abnormalities by various workers. Brindley¹ suggests that the defect is congenital and not the result of accidental injury. Eigenmann and Cox² regard the abnormality as a pre-potent variation while Willey³ considers it as "natural mutation among fishes". Hora⁴ believes that such abnormalities may be due to the result of injury to anlagen of the ventrals in developing embryos.

From the size of the specimens under reference, it appears that the abnormalities have not affected the growth of the fishes. Since the place of origin of fins was covered with scales and did not show any mark, the abnormalities cannot be the result of any physical injury. The absence of entire pelvic girdle in *Cirrhitina variegata* also points out that the defect has not resulted from physical injury.

The author is extremely grateful to Mr. H. L. Sarkar for helpful suggestions and to Prof. M. L. Bhatia for providing facilities in the Department of Zoology, University of Delhi.

National Council of N. K. KAUSHIK.
Applied Economic Research,
Parliament Street,
New Delhi, July 5, 1960.

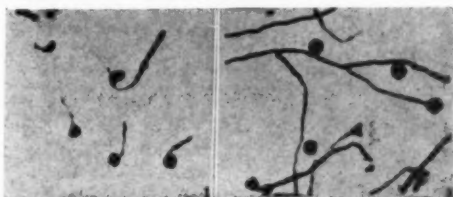
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POLLEN IRRADIATION AND CULTURE OF POLLEN TUBES OF COCONUT

In order to determine the LD-50 dosage for coconut pollen, pollen of two tall and dwarf varieties were irradiated with γ -rays at the 4750 curies Co⁶⁰ unit of the U.S. Atomic Energy Commission at the World Agriculture Fair, New Delhi. Dosages ranging from 500 to 1,00,000 rads

were given to separate anthers. Pollen germination was normal in dosages up to 25,000 rads but was completely inhibited at 50,000 rads and above. The LD-50 dosage determined on the basis of *in vitro* culture of pollen tubes may not, however, provide an index of the functionality of pollen as reflected in seed-setting. Hence data on seed-setting using dosages of 25,000 rads and below will have to be undertaken to determine the dose most suitable for mutation experiments. But a high dosage like 25,000 rads which does not inhibit the germination and growth of pollen may be suitable in experiments designed to induce the parthenogenetic development of the unfertilized egg cell.

Patel¹ observed that coconut pollen germinate well in a mixture of 5% sugar and 2% gelatin. Various concentrations of sugar solution as well as water from tender coconuts have also been found useful for this purpose.² The author found that germination was satisfactory when pollen were kept at 25°C. in 10% sucrose and 2% gelatin. The growth of the pollen tubes was, however, strikingly better when boric acid was added to the culture medium (Figs. 1 & 2). The



FIGS. 1-2 Pollen tubes of a tall variety of coconut. 3 hours after culture. Fig 1. Sucrose gelatin medium. Fig. 2. Sucrose gelatin-boric acid medium.

following procedure was found to be the best among those tried by the author. Dissolve 2.5 g. of sucrose and 0.5 g. of gelatin in 25 c.c. of 30 p.p.m. solution of boric acid. The mixture needs slight warming to dissolve the gelatin. To get an uniform distribution of pollen grain, make a suspension of the pollen in the above medium either in gelatin capsules or in glass tubes and smear the suspension on a slide. Keep the slide in a Petri-dish covered with moist filter-paper on either side. Place the Petri-dish in an oven at 25°C. The slides can be examined after 2-3 hours.

The author is grateful to the Joint Director, Central Coconut Research Station, Kasaragod, for kindly sending coconut inflorescences for irradiation and for deputing him to the I.A.R.I. and to Dr. J. L. Brewbaker for providing facil-

ties for carrying out the treatments. The author's thanks are due to Messrs. C. Bhatia, J. Prasad and M. Upadhyaya who carried out the irradiation. He is indebted to Dr. A. B. Joshi, Head of the Division of Botany, for facilities and Dr. M. S. Swaminathan and Dr. S. Bhaskaran for advice.

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STUDIES ON TWO BACTERIAL DISEASES OF SUGARCANE

RED-STRIPE disease caused by *Xanthomonas rubrilineans* (Lee et al.) Starr and Burkholder and gummosis caused by *X. vasculorum* (Cobb.) Dowson are two of the most severe bacterial diseases of sugarcane.¹ The former is known to be prevalent in some parts of India²⁻⁵; perhaps the latter disease is also present in India, but no investigation into the disease to establish the causal organism seems to have been made so far.

During February-March 1958 the two diseases were observed in the Nellikuppam Sugar Factory areas of South Arcot District, Madras State, and in subsequent years they were also observed in the neighbourhood of Chidambaram of the same district. The two diseases were investigated in some detail and the results are briefly reported here.

The red-stripe disease was observed on the varieties Co. 449 and Co. 527 in the Nellikuppam area and on Fiji B in Chidambaram. The symptoms were characteristic of the disease as described by Edgerton,¹ but on the variety Fiji B younger leaves were more commonly affected as against Co. 449 and Co. 527, wherein the older leaves were mostly affected.

In the case of gummosis, affected plants are stunted, leaves paler than normal, and canes thinner; when cut open, characteristic gummy liquid oozes out from the cut surface. In advanced cases cavities develop in the centre of the canes, sometimes resulting in dry rot and pithiness (Fig. 1: 3 and 4). Also, shoot rot symptoms were observed in some affected plants; the plant tops rot with dark-red discolouration of the central shoot (Fig. 1: 1). Sometimes numerous shoots arise from the lower nodes

giving the characteristic multiple shoot (Fig. 1: 2). When the canes are split open the characteristic reddening of the vascular strands is observed.

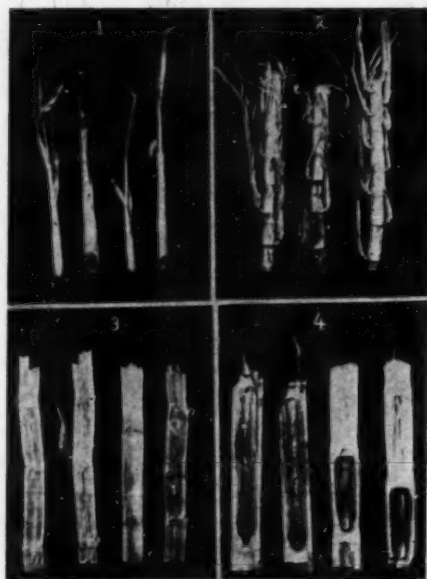


FIG. 1. *Xanthomonas vasculorum* on sugarcane (1) Shoot rot; (2) multiple shoot; (3) gummosis and (4) central cavity and pithiness of affected canes.

Several isolations of the bacteria were made from the diseased plants and their pathogenicity established by inoculating on healthy leaves (sugarcane variety Co. 449), following the method recommended by Nour and Nour⁶ and also into the canes by the usual wound inoculation. The disease symptoms were reproduced by the inoculations, the organisms re-isolated from the affected tissues and found to be identical with the original inocula.

The bacteria were studied for their morphological, cultural and physiological properties. The one causing red-stripe was found to be identical with *X. rubrilineans* and the other causing gummosis to be identical with *X. vasculorum*, as given in *Bergey's Manual of Determinative Bacteriology*.⁷

The two bacteria were studied for their host range by inoculating the leaves of one month old plants, raised for the purpose in the greenhouse. The results obtained are summarised in Table I.

Sorghu
Zea ma
Pennis
Panicu
Brachi
Eleusin
Setaria
Panicu
P. mil
Chloris
Paspal
Cenchr
Echino

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TABLE I
Host range of the bacterial isolates from
sugarcane

Name of host	Results of inoculation	
	<i>X. rubrilineans</i>	<i>X. vasculorum</i>
<i>Sorghum vulgare</i> Pers.	+	-
<i>Zea mays</i> L.	+	+
<i>Pennisetum typhoideum</i> Rich.	+	-
<i>Panicum antidotale</i> Retz.	+	+
<i>Brachiaria mutica</i> Stapf.	+	+
<i>Eleusine coracana</i> Gaertn.	-	-
<i>Setaria italica</i> Beauv.	-	-
<i>Panicum miliare</i> Lam.	-	-
<i>P. miliaceum</i> L.	-	-
<i>Chloris gayana</i> Kunth.	-	-
<i>Paspalum scrobiculatum</i> L.	-	-
<i>Cenchrus setigerus</i> Vahl.	-	-
<i>Echinochloa frumentacea</i> L.	-	-

The results reveal that *S. vulgare*, *P. typhoideum*, *P. antidotale* and *B. mutica* are new hosts for *X. rubrilineans* and *P. antidotale* and *B. mutica* are new hosts for *X. vasculorum*.

Dept. of Agriculture, G. RANGASWAMI.
Annamalai University,
Annamalainagar (Madras State),
June 1, 1960.

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ON THE OCCURRENCE OF SMALL-SIZED MACKERELS (*RASTRELLIGER CANAGURTA* (CUVIER) OFF RATNAGIRI COAST*

Young mackerels below 10 cm. in length were not so far reported or studied from the Kanara or Konkan Coast except for an isolated record from Karwar (Pradhan, 1956) and hence this report on their occurrence from this zone should be of considerable interest. Small-sized specimens were so far recorded only from Calicut (Bhimachar and George, 1952), Vizhingam (Balakrishnan, 1957), Madras (Rao and

Basheeruddin, 1953 and Kuthalingam, 1956) and Waltair Coast (Rao and Rao, 1957).

Small-sized mackerels ranging in size from 62 and 112 mm. in length were observed in the cast-net catches on 24-9-1959 from Pawas fishing village, near Ratnagiri, during routine collection of fishery survey and catch statistics data. The catches were made from a depth of about eight fathoms and one kilogram of the material contained two hundred and eight specimens. The total catch of young mackerels weighed about four kilograms and these occurred along with moderate catches of *Anchoviella tri*. The dominant sizes, observed in the sample analysed, were the 78 and 88 mm. groups. There was no fishing during the subsequent days for about a week due to stormy weather conditions and hence further catches were not available for study.

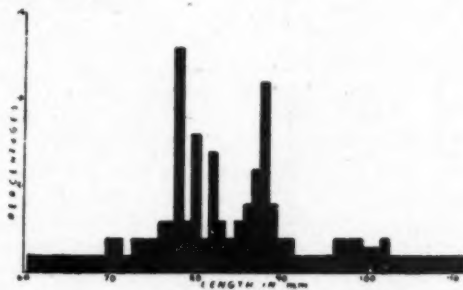


FIG. 1

The food of these small-sized mackerels, as revealed in the analysis made of their gut contents, consisted of diatoms, dinophysisids, copepods and penaeid protozoae. The stomach inclusions did not show "fish larvae as staple food", as has been reported from Waltair (Rao and Rao, 1957) and the feeding intensity was also found to be appreciably high.

The main season of spawning of the Indian mackerel on the Konkan Coast, according to Pradhan (1956), is from May to September. A subsidiary spawning season was observed on the Mangalore Coast during January and February by George *et al.* (1959). The occurrence of small-sized mackerels during September indicates that these were spawned a few months earlier and adds strength to the contention that the Indian mackerel may have a prolonged spawning season, or a subsidiary season along this coast or both.

A detailed study of the ecology of the juvenile mackerels with special reference to feeding

relationship is in progress and will be published elsewhere.

The authors are grateful to Shri R. V. Nair for helpful criticism of this note and to Dr. S. Jones for encouragement.

Central Marine Fisheries P. C. GEORGE.
Research Station, G. G. ANNIGERI.
Mandapam Camp, April 1, 1960.

*Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

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FIELD RESISTANCE TO BLIGHT (*PHYTOPHTHORA COLOCASIA* RAC.) IN *COLOCASIA ANTIQUORUM*, SCHOTT.

TARO yam, dasheen or arvi (*Colocasia antiquorum*), which is an important tuber crop grown for vegetable in many parts of India, usually suffers from the blight disease caused by *Phytophthora colocasia* Rac. during the monsoons (Butler, 1918). While assessing the varietal collection maintained at the Central Potato Research Station, Patna, for blight reaction, it was observed that whereas the local variety 'Patna Local' succumbed completely to the onslaught of the disease in an epidemic during 1958, another variety, Ahina, obtained from Assam, withstood the disease infection fairly well under similar field conditions. In both the varieties the disease appeared as infected black or brown spots, circular in shape. As the disease developed under field conditions, the spots increased in size, sometimes they coalesced and the shape of the infected area became irregular. In the susceptible variety, usually within a week after the first appearance of the disease, nearly all the leaf area got infected and died. In the resistant variety, on the other hand, the progress of spread of disease was slow and within the same period the infected areas on the leaves were much smaller than those on the susceptible variety. However, as the disease spread, the entire leaf of the resistant variety also succumbed to the disease, a week or ten days later

than the susceptible type. This type of reaction, known as field resistance, is already known in certain varieties of potato (*Solanum tuberosum*) and in other potato species and is equally effective against all the physiological races of the fungus. Deshmukh and Howard (1956), while studying the blight reaction in two potato varieties, Arran Pilot (very susceptible) and Ackersgen (field resistant), observed that the main differences between the two varieties were the length of the incubation period of the fungus and the number of spores produced. The results indicated in this note have emerged from a study of late blight reactions made in *Colocasia* on 'Patna Local' and Ahina varieties during 1958.

TECHNIQUE

Leaf-pieces 2" x 2" in size were placed with ventral surface upwards on a moist blotting-paper put in an enamel dish 12" x 10" x 2" in size. The dish was covered with a glass plate to which was attached a moist blotting-paper from inside. Leaf-pieces, 4 each of the 2 varieties, were placed in one dish. The pieces were artificially inoculated with a weak spore suspension by means of an atomizer. Counting of spores was done by washing the sporulated leaf-piece in ½ c.c. of distilled water, placing a drop from the washed suspension on a slide and observing the spores in different fields obtained under a microscope with × 10 and × 100 pieces.

RESULTS

1. *Length of the Incubation Period.*—Although the actual period required for sporulation varied from 41 to 50 hours after inoculation in different tests both the varieties sporulated at the same time on each occasion.

2. *Number of Sporangia.*—The average number of sporangia counted under the field of the microscope in the case of the two varieties infected artificially is indicated in Table I.

It would be apparent from Table I that the susceptible variety 'Patna Local' produced sporangia about four times more than the field-resistant variety, Ahina. The difference in the degree of sporulation seemed to remain constant in the two varieties at least for the duration of 45 to 97 hours after inoculation for which observations were recorded.

3. *Spread and Intensity of Infection.*—Infected leaf areas, usually circular in shape, obtained after inoculation and sporulation, were measured. It was observed that the infected area on the leaf of 'Patna Local' was about 3.3 cm. in

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TABLE I
Showing number of Sporangia obtained from:
artificially-infected leaf-pieces of 'Patna
Local' and Ahina

Date of inoculation	Time required for sporulation	Length of time after inoculation when spores were counted	No. of samples examined	No. of sporangia on percentage basis in	
				Patna Local	Ahina
18-8-1958	hrs. 45	hrs. 45	27	100	21.9
20-8-1958	41	67	72	100	27.0
22-8-1958	50	77	72	100	24.8
23-8-1958	50	97	63	100	25.1

diameter whereas in the case of Ahina it was about 2.8 cm. Another interesting observation was that the colour of the infected region in 'Patna Local' was pale-brown but it was deep-black in the case of Ahina (Fig. 1).

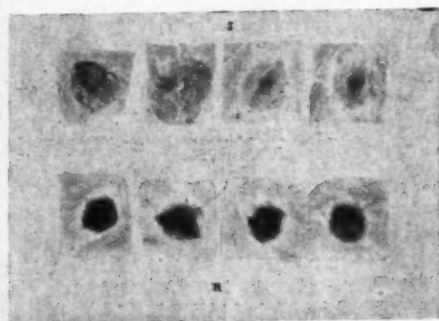


FIG. 1. Artificially infected leaf-pieces showing infected areas.

S: Susceptible variety, 'Patna Local'.
R: Resistant variety, Ahina.

DISCUSSION

The field-resistant variety, Ahina, differed from the susceptible one, 'Patna Local' in the number of sporangia produced, although the length of incubation period of the fungus was same in both. The number of sporangia produced on the former was about four times less than the latter. This would naturally mean a slow rate of spread of the disease under field conditions.

The size of the infected area in the two varieties indicated that the fungus had a relatively slow rate of growth in the field-resistant variety.

The difference in the colour of the infected region in the two types may possibly be due to the nature of the reaction between the host and the parasite. The reaction was severe in the case of the resistant type as a result of which there was a rapid but not sudden death of the leaf tissue which turned into a deep-black colour after the infection. That would mean that in *Colocasia* field-resistance is essentially a hyper-sensitive reaction but of a weak nature.

ACKNOWLEDGEMENTS

Our sincere thanks are due to Dr. Pushkar-nath, Director of the Institute, for his kind encouragement and helpful suggestions.

Central Potato Research Institute,
Simla, May 2, 1960.

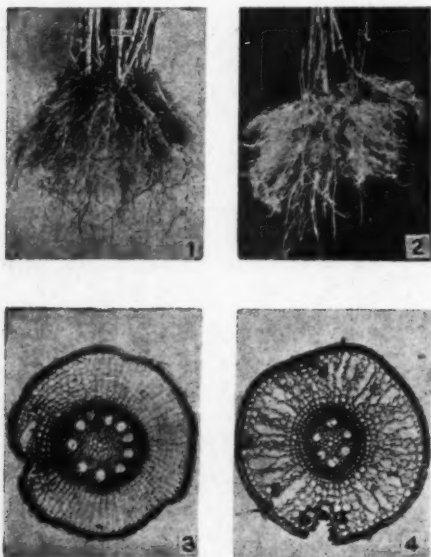
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CERTAIN ADAPTIVE CHARACTERS OF GENETIC STALKS OF *SACCHARUM SPONTANEUM* L. TOLERANT TO WATER-LOGGED CONDITIONS

VAST areas under the sugarcane crop in North Bihar, Eastern Uttar Pradesh, Punjab and West Bengal are liable to flooding and water-logging during the monsoon. The need for evolving suitable commercial varieties resistant or at least tolerant to waterlogged conditions for such areas has been felt ever since breeding work started at Coimbatore. Certain clones of the wild cane, *Saccharum spontaneum*, are noticed in nature to grow well under water-logged conditions. This observation was made use of in utilising this species in sugarcane breeding and the first commercial hybrid, Co. 205 was observed by Venkatraman and Thomas¹ to grow well under water-logged conditions in the Punjab. Das² has referred to the growing of this variety in a field which had been under water continuously for five months.

In the Spontaneum Expedition Scheme (S.E.S.) at this Institute, studies are in progress on the breeding value of the large number of clones collected from India and abroad for such characters as disease and pest resistance and tolerance to adverse environmental conditions.³ In the course of these studies, twenty-eight selected clones coming from areas subject to inundation were tested under artificial water-logged conditions for a period of six months.

Periodical data were recorded on growth, tillering, number of green leaves, greenness of foliage, etc., both in the treatment and in the control which was an uninundated plot. Out of the 28 clones, 7 stood out prominently as showing good performance under water-logged conditions. These are collections from Uttar Pradesh, Assam, Punjab and Nepal. Among them S.E.S. 334 collected from Nowgong, Assam and S.E.S. 340 from Manipur were the best in the matter of growth, tillering and lushness of foliage. These clones were characterised by considerable adaptability to the anaerobic conditions by the production of a large matrix of fibrous roots (Fig. 2) round the clumps



FIGS. 1-4. Root system and root anatomy under normal and water-logged conditions.

as also a large number of negatively geotropic, rather aerotropic roots which come up above the water level as in mangroves. This was in contrast to the normal root system noticed in the control (Fig. 1). Transverse sections of the root (Fig. 4) revealed the presence of aerenchyma in the cortex which, as is known, is an adaptation for thriving under hydrophytic conditions as against the normal root anatomy (Fig. 3). Such roots have been known to develop in the commercial variety Co. 285 which withstands water-logging to a considerable extent. Sartoris and Belcher⁴ have recorded development of nodal roots forming a matrix in sugarcane varieties. Shah⁵ has recorded in

Co. 442 "the faculty of producing negatively geotropic (breathing) roots rather profusely under water-logged conditions". The two clones S.E.S. 334 and S.E.S. 340 thus appear to be capable of withstanding water-logged conditions to a good extent and may serve as suitable genetic donors of tolerance to water-logged conditions in the breeding of sugarcane varieties.

The other clones which also recorded the presence of the fibrous matrix and negatively geotropic roots to a certain extent and showed good growth were S.E.S. 267, S.E.S. 278, S.E.S. 279, S.E.S. 351 and S.E.S. 367.

Certain of the above clones which have flowered regularly at Coimbatore have been used in breeding. S.E.S. 340 has not so far flowered under Coimbatore conditions and some others are shy flowerers. Attempts are being made to induce adequate flowering in them, by photoperiodic treatments for purposes of crossing.

Details will be reported elsewhere.

Thanks are due to Dr. N. R. Bhat, Director, for encouragement and guidance.

Sugarcane Breeding Institute, K. SRINIVASAN,
Coimbatore-7, J. T. RAO.
May 12, 1960.

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INFLUENCE OF NEUTRON RADIATION ON SEX-RATIO IN CITRULLUS VULGARIS (WATERMELON)

It has been shown by several authors (Hanson, 1928; Muller, 1928; Gowen and Gay, 1933; Bauer et al., 1938 and Lea and Catcheside, 1945) that when progenies were raised from irradiated *Drosophila* males the sex-linked lethals were more in the females than in the males. This was attributed to the greater radio-sensitivity of the X-bearing sperms as shown by the higher frequency of radiation-induced breaks occurring in the X-chromosome as compared to those in the Y-chromosome of Y-bearing sperms. In plants, however, Scully et al. (1951), observed that in the progeny from thermal neutron irradiated seeds of *Cannabis sativa*, the sex-ratio was altered as a result of reduction of the number of male plants. That this condition is not always found can be seen from the earlier observations of Lorbeer (1936), who

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reporting the occurrence of antheridial growth in the X-irradiated archegonial growing point of *Sphaerocarpus*. Evidence from experiments of Nitsch *et al.* (1952), Over Beek (1952), Chaudhari (1957), Mallik *et al.* (1959) and others on a number of plants, however, indicate that by using certain chemicals, the frequency of female flowers can be increased without affecting the proportion of male flowers.

Monoecious plant species with male and female flowers borne separately on the same plant offer interesting possibilities for studies on the effect of ionizing radiations on sex-ratio. *Citrullus vulgaris* (Watermelon), a monoecious plant, belonging to the family Cucurbitaceae, was selected for investigations on the influence of neutrons on sex expression.

Dry seeds of two varieties, Midget and Asahi yamato, obtained from Indian Agricultural Research Institute, New Delhi, were irradiated with 1×10^{12} np./cm.², 5×10^{12} np./cm.² and 7.5×10^{12} np./cm.² of pile neutrons from the reactor Apsara. The irradiated seeds were immediately sown in the field along with unirradiated controls. While the control plants and those raised from seeds receiving 1×10^{12} np./cm.² flowered simultaneously, anthesis was delayed by about 3 weeks in plants which had earlier received higher doses. The counting of flowers was started about 2 months after the sowing and continued for 45 days. Only the open flowers were counted.

high doses were altered not as a result of decrease in the frequency of male flowers but due to the proportionate increase in the number of female flowers. Heterogeneity χ^2 test showed that the difference in the sex-ratio was highly significant, (Midget- $\chi^2 = 62.07$, $P < 0.001$, Asahi yamato- $\chi^2 = 26.55$, $P < 0.001$).

The similarity of the present results with those obtained from chemical treatments suggest a parallel mechanism of action of radiations and chemicals. The effect on the sex-ratio appeared to be of physiological nature and it seems likely that the potential sporogenous cells were affected by irradiation during the initial stages of their development. It is, however, not known whether the excess of female flowers were derived from the would-be male primordial cells or from non-sporogenous cells. It is most likely that former was the case.

The effect of neutrons on the sex expression in watermelon appears to be unidirectional and to favour the female. Whether the supernumerary female flowers were basically similar with the normal ones in respect of development of the fruit and the seed and the behaviour of their subsequent progeny, or different, is not known; nor is it known how they were produced. Although it is certain that the alteration of the sex-ratio was brought about through a genetically controlled sex mechanism there is very little information on the site(s) of reaction or

TABLE I
Relationship between neutron dose and sex-ratio in *Citrullus vulgaris*

Variety	Neutron dose	No. of plants	♀ flowers		♂ flowers		Sex-ratio ♀ : ♂	Survival % 15 days after germination
			Total	Per plant	Total	Per plant		
Midget	.. Control	14	147	10.5	1519	108.5	1 : 10.3	47
Asahi yamato	.. do.	29	141	4.8	1407	48.5	1 : 9.9	80
Midget	.. 1×10^{12} np./cm. ²	15	185	10.3	1617	107.8	1 : 10.4	40
Asahi yamato	.. do.	19	51	2.7	558	29.4	1 : 10.9	91
Midget	.. 5×10^{12} np./cm. ²	16	311	19.4	1760	110.0	1 : 5.7	27
Asahi yamato	.. do.	17	95	5.6	538	31.6	1 : 5.6	69
Midget	.. 7.5×10^{12} np./cm. ²	11	182	16.5	1034	94.0	1 : 5.6	22
Asahi yamato	.. do.	9	136	15.1	867	96.3	1 : 6.4	24
Total	.. ..	130	1218	..	9300	..	..	..

It was observed (Table I) that among the control populations of both the varieties, for every female flower there were ten male flowers. This ratio (1 : 10), although remained unchanged at the dosage level of 1×10^{12} np./cm.², was altered appreciably at higher doses.

It is of interest to note that the sex-ratios at

on processes intervening the primary action of radiation and the expression of the sex. Experiments are in progress to gather further information on the subject.

Biology Division,
Atomic Energy Establishment, K. C. BORA.
Trombay, June 18, 1960.

R. G. THAKARE.

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ONION SMUT IN MYSORE

ON reporting about the appearance of smut on onion and garlic in Mysore, Mr. N. S. Venkatarishniah (*Curr. Sci.*, **29**, 26-28, Jan. 1960) says that the disease was observed for the first time in Mysore in a field near Melur in Sidlaghatta Taluk of Kolar District in July 1958 on young seedlings of the Chickballapur variety of onion. This is not, however, the first report of its occurrence in Mysore. Mention is made in the Report of work done in the Mycological Section during 1920-21 by Mr. M. J. Narasimhan in the Report of the Sixth Annual Conference of the Officers of the Agricultural Department (August 1921). Having had to examine the specimens then, I am in a position to state that they were collected by Mr. T. V. Subramaniam, then Assistant Entomologist, from Chickballapur on 28th July 1920. It is interesting to observe that the present notice of its appearance is on the Chickballapur variety of onion, and at a place only fourteen miles to the south-east of Chickballapur. The disease had not been noticed since then.

Urocystis cepulae is chiefly a fungus of the temperate regions. In Asia it occurs only in Japan and Central Asia (U.S.S.R.). It is almost absent from the tropics except for Puerto Rico in the West Indies and Queensland in Australia. It is of interest to note that the fungus was found on onions in 1922, 1924 and 1925 at Winnipeg, Manitoba, Canada, (Bisby, G. R., Buller, A. H. R., and Dearness, J., *The Fungi of Manitoba*, Longmans, Green & Co., 1929, p. 31). Butler, E. J. and Bisby, G. R. ("The fungi of India", *The Imp. Coun. Agr. Res. Sci. Mono.* **1**, 1931) on comparing the fungi of India, the Dutch East Indies, and Manitoba, state that of 100 Ustilaginales in India, 11 are common to India and Manitoba, while of 36 in Manitoba, 30.6% (again 11) are also in India. This is noteworthy

because the disease originated in Connecticut, U.S. of America in 1860, and spread to Europe and elsewhere through consignments of seed. The fungus affects only the crop from seed up to a certain age, even though it may be present in the soil. Onions grown from setts are immune. This accounts for its isolated appearance.

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July 11, 1960.

STUDIES ON VIRUS DISEASES OF PLANTS IN MADHYA PRADESH

III. The Yellow-Net Disease of *Eclipta prostrata* Linn.

THE author first observed the disease under report in certain localities of New Delhi between 1947 and 49. The same disease was noticed in certain localities of Indore in the year 1952 and again in 1953. Since then the disease has been observed every year. Capoor and Varma¹ have also mentioned the occurrence of the disease in Bombay. Considering the wide range of occurrence its investigation was taken up in the year 1954.

Symptoms.—The chief symptom of the disease is the yellow colouration of the leaf veins. The leaves show a homogeneous interwoven network of yellow veins enclosing islands of green tissue within (Fig. 1). In the later stages of the disease the chlorosis, which in the beginning is strictly



FIG. 1

confined to the veins, may extend to the interveinal portions of the lamina and such leaves become completely chlorotic except for a few very small green patches scattered over the leaf surface. In extreme cases a leaf may become completely yellow. Such leaves show a marked reduction in size. There is no visible effect of the disease on any other part of the infected plant which bears flowers and produces seeds also.

Transmission.—Young, healthy *Eclipta* plants raised under insect-proof conditions from seeds collected from healthy plants in nature were inoculated in the usual way with the juice extracted from severely infected leaves, using carborundum powder as an abrasive. The experiment was repeated at different intervals during the period from July to October when the disease is very common in nature. None of the inoculated plants developed the symptoms of the disease showing thereby that the disease is not transmissible by mechanical means.

In order to ascertain if the disease is transmissible by grafting, shoots from diseased *Eclipta* plants were grafted on healthy vigorously growing *Eclipta* plants by wedge-grafting method. The grafted plants were covered individually with large-sized lantern globes closed with cellophane on the top and kept humid for over two weeks in order to ensure union between the healthy stock and the diseased scion. The experiment was repeated a number of times. In case of successful grafts the first symptoms of the disease appeared on the stocks two to three weeks after the date of grafting when they produced new shoots (Fig. 2). The disease started in the form of yellowing of the leaf veins. All subsequently developed leaves on the stocks showed typical symptoms of the disease.

During the present investigations it has been observed that in nature the underground parts of many *Eclipta* plants persist in the soil during the unfavourable period though their aerial portions die. On return of favourable season new shoots are given out by the underground perennating parts. Those plants that had the disease in the previous year produce shoots showing typical symptoms of the disease from their perennating underground parts. The disease spreads from these plants to new healthy ones in all probability through the agency of some insect because it is not transmissible by sap inoculation. The tests conducted with white flies (*Bemisia tabaci* Genn.) which are quite common on *Eclipta* plants in nature have, however, given negative results.

Host range.—Healthy seedlings of *Lycopersicon esculentum* Mill., *Datura innoxia* Mill., *Sida rhombifolia* L., *Helianthus annuus* L., *Zinnia elegans* Jacq., and *Tagetes* sp. were cleft-grafted with scions from diseased *Eclipta*. The disease was not transmitted to any of these plants. Thus the virus responsible for the disease under report is, according to our present observation, confined to *Eclipta* only.



FIG. 2

Capoor and Varma¹ mentioned the occurrence of yellow-vein symptoms on *Eclipta*, *Sida* and a few other plants in nature but no attempt appears to have been made to prove the virus origin of these symptoms. During the present investigations the virus origin of the disease on *Eclipta* has been fully established. The symptoms produced by the disease under report on *Eclipta* resemble to some extent those produced by beet yellow-net disease virus on beet and the yellow-net virus disease of tomato on tomato (Sylvester).^{2,3} The former is, however, confined to beet only and has not been transmitted to members of Compositae family to which *Eclipta* belongs and the virus from *Eclipta* does not infect tomato. The disease on *Eclipta* has therefore to be considered distinct.

My thanks are due to Dr. W. V. Bhagwat, Principal, and Shri D. W. Kshirsagar, Head of

Botany Department, for providing facilities for work. I am indebted to my colleague Shri Ramji Sharma for the photographs used in this article and for his help in the preparation of the manuscript.

Department of Botany,
Holkar College, Indore.
October 30, 1959.

R. P. GARGA.

1. Kapoor, S. P. and Varma, P. M., *Ind. J. Agric. Sci.*, 1950, **20**, 217-30.
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THE CHROMOSOMES OF *ORYZA* *RIDLEYI* HOOK.

THE species *O. ridleyi* Hook. is one of the 25 described with species in the genus *Oryza* and has been collected only from South-east Asia. Seeds of this species, secured from Malaya, were grown and the chromosome number was determined to be $2n = 48$, both from mitotic as well as meiotic divisions and this number has been recorded in the monograph *Rice in India*.¹ Recently Van² records that the chromosome number of Malayan *O. ridleyi* is $2n = 24$. Therefore the plants were re-examined to check the chromosome number.

This species is indigenous to Malayan forests and grows in rain forest shade. The plant is tall, semi-erect with some external resemblances to a diploid species of *Oryza*, namely, *O. granulata* Nees. The leaves are glabrous, linear, lanceolate, 25 to 35 cm. long and 2 to 2½ cm. in width. The panicle is contracted with short rachilla. Spikelets are 8 to 15 mm. long with 8 to 10 mm. long awns and sterile lemma is setaceous and conspicuous being 6 to 7 mm. in length. There is no rhizome development as is found in the akin species, *O. granulata*. The plants are season-bound and flower only during short days as observed under Cuttack conditions.

The uprooted plants were rooted in sand and a study of the root-tip cells showed that the chromosomes were undoubtedly above 24, and Fig. 1 shows one clear plate having 48 chromosomes. Since the plates were very crowded and individual chromosomes difficult to identify, studies of meiotic division were also made. The flower-buds prefixed in propionic alcohol (1:3) containing a trace of ferric acetate were smeared in acetocarmine and clear division-stages were obtained. A microphotograph of a well-spread

plate did show 24 bivalents. In addition to these cells carrying one to two quadrivalents were also seen. Anaphase stages also showed occasional bridges not exceeding two in number. There was not a single instance of the diploid number ($2n = 24$) being present in any of the cells. Therefore the type grown by us is a tetraploid.



FIG. 1. *O. ridleyi*. Somatic Metaphase ($2n = 48$) $\times 4,000$.

The plants showed a high degree of sterility. The percentage seed-setting was nearly nil under certain conditions. It was found that this could not be attributed to tetraploidy alone, because in many spikelets the anthers were reduced and could be called "vestigial". It was also observed that conditions of culture strongly affected fertility. The fertility was higher under humid conditions of October and November at Cuttack and decreased rapidly later. The pollen fertility ranged from 4 to 90% in the different samples taken periodically, thus showing the effect of environment on fertility.

One more collection of *O. ridleyi* was secured from Bangkok, through the help of Dr. H. I. Oka. The plants were similar to the first and differed only in having deeper purple colour in the stigma. The chromosome number of this collection has also been found to be $2n = 48$.

The authors are grateful to Dr. R. H. Richharia, Director, for his keen interest in this work and to Sri. S. Sampath, Cytologist, for his valuable suggestions and encouragement.

Central Rice Res. Inst.,
Cuttack,
April 7, 1960.

D. V. SESHU.
B. KARIBASAPPA.

1. Ghose, R. L. M., Ghatge, M. B. and Subrahmanyam V., *Rice in India*, I.C.A.R., New Delhi, 1956.
2. Van, T. K., *I.R.C./Prod.* 59/4, 1959.

REVIEWS

Probability and Related Topics in Physical Sciences, Vol. 1. *Lectures in Applied Mathematics. Proceedings of the Summer Seminar, Boulder, Colorado, 1957.* By Mark Kac with G. E. Uhlenbeck, A. R. Hibbs and Balth. Van der Pol. (Interscience Publishers, Inc., New York); 1959. Pp. 266. Price \$ 5.60.

This is not a regular text-book but is a collection of lectures intended to give an introduction to probability theory to a mature audience. As such, the book does not give an exposition of the subject but deals with a set of selected problems, the choice of which depending on the tastes, inclination and prejudices of the lecturers.

The first chapter (Nature of Probabilistic Reasoning) serves to illustrate the application that probability theory finds in diverse subjects such as the kinetic theory of gases, the theory of equations and number theory. The second lecture deals with the problem of random walk. The third (and longest) lecture deals with the well-known problems of the connection between classical reversible mechanics and the second law of thermodynamics. This chapter is supplemented by two lectures (reproduced in Appendix I) by Professor G. E. Uhlenbeck on the Boltzmann equation. Chapter four gives a lucid account of the Wiener integral and some applications like the Feynman integrals and the Wigner-Kirkwood expansion of the quantum dynamical partition function.

The book is supplemented by four appendices respectively by Uhlenbeck, Hibbs and Van der Pol. The second appendix by Hibbs describes Feynman's path-integral method. This is followed by two appendices by Van der Pol respectively on 'Smoothing and Unsmoothing' and 'The Finite-Difference Analogy of the Periodic Wave Equation and the Potential Equation'. The appendices as a whole form a valuable part of the book and give lucid and beautiful expositions on topics of current interest.

The aim of the author has been to present the physical and mathematical principles of probability theory, borrowing the least from abstract measure theory and the book will therefore find its appeal to a wide class of scientists. The lucid presentation of the topics discussed in the book coupled with their usefulness and current interest make this volume a valuable addition to the literature on probability theory. V.

Fundamentals of Electronics. By F. H. Mitchell. (Published by Addison-Wesley Publishing Co., Inc., Reading, Mass., U.S.A.), August 1959. Pp. 260. Price \$ 6.50.

A basic knowledge of electronics always comes in handy to scientific workers belonging to different disciplines, engaged in experimental research, as modern methods of instrumentation is inseparably bound up with electronic circuitry and electronic devices. A wide choice of books presenting the subject, in a fashion understandable to non-electronics people is not easily secured. The present volume is a happy blending of material that would just provide the right background. The first two chapters discuss fundamentals of direct and alternating current circuits respectively. In Chapters 3, 4, 5 and 6, the characteristics of conventional electron tubes and their applications are set out. Amplifiers, oscillators and the factors involved in their design and operation are covered in Chapters 7, 8 and 9. Various types of gas-filled tubes, their characteristics and the basic circuits having such tubes as functional elements, make up Chapter 10. In Chapter 11, under the heading "Special Purpose Tubes and Devices", a short description and the principle of operation of several non-conventional types, such as phototubes, electron multipliers, C.R.T., U.H.F. tubes, velocity modulation devices and magnetrons are given. Chapters 12 and 13 are the two very attractive features of the book. The former under the title "Wave-shaping and Control Circuits" describes circuitry which one comes across very frequently in modern applications. Chapter 13 deals with two specific electronic instruments, namely, the V.T.V.M. and C.R.O. which are very frequently used for purposes of measurement.

The book would have become complete with a brief account of transistors and this aspect is indeed a shortcoming. It could also have been priced at a somewhat moderate level, in which case it would attract a larger number of readers.

The reviewer strongly recommends the book to all those who want to get a basic understanding of this fascinating subject, without unduly getting into complexities and it would serve very well for a first course in electronics.

A. J.

The Cathode-Ray Tube and Its Applications. Third Revised Edition. By G. Parr and O. H. Davie. (Chapman and Hall, London; India: Asia Publishing House, Bombay-1), 1959. Pp. 433. Price 50 sh.

The first edition of this book was published in 1937 under the title "The Low Voltage Cathode-Ray Tube" as a guide to the operation and use of the tube. Oscillography has advanced in the last twenty years and numerous are its applications today covering a wide field and there are special tubes for different purposes. It may be said that technology of cathode-ray tube-making has reached the limit of perfection in the tubes used in television cameras. The present volume concerns itself with the cathode-ray tube as a measuring instrument and deals in detail with the various circuitry that goes to make up a cathode-ray oscillograph.

The contents of the book are divided among sixteen chapters. After a brief historical treatment in Chapter 1 the tube proper, its construction and performance are dealt with in Chapter 2. Chapters 3 to 8 describe power supplies, amplifiers, time bases, auxiliary circuits and frequency bases. Chapter 9 is wholly devoted to photographic recording. Chapters 10 to 13 deal with the application aspect in the fields of mechanical, electrical and radio engineering. Chapter 14 deals with oscillographs for television measurements, and application to general and nuclear physics are briefly indicated in the next. Electro-medical applications and display of functions and patterns are set out in the last chapter.

The book is very well written and is illustrated with numerous circuits. References are given at the end of each chapter. The reviewer warmly recommends this publication to all those who use this versatile instrument either for measurement or display.

A. J.

Advances in Spectroscopy, Vol. 1. Edited by H. W. Thompson. (Interscience Publishers, New York and London), 1959. Pp. viii + 363. Price \$ 12.50.

Spectroscopic studies throw valuable light on atomic and molecular energy levels and play an important role in physico-chemical researches as a valuable analytical tool. The subject has in recent years grown rapidly and now consists of numerous specialized branches. The proposal to publish a series of annual volumes—to present, interpret and evaluate significant recent

accomplishments in spectroscopy and indicate the most promising lines of advance—is a step which will be welcomed by all those engaged in spectroscopic studies. This first volume consists of the following eight articles, viz., (i) The spectra of polyatomic free-radicals: By D. A. Ramsay, (ii) Spectroscopy in the vacuum ultraviolet: By W. C. Price, (iii) The index of refraction of air: By D. H. Rank, (iv) Determination of the velocity of light: By D. H. Rank, (v) High resolution Raman spectroscopy: By B. P. Stoicheff, (vi) Modern infra-red detectors: By T. S. Moss, (vii) The infra-red spectra of polymers: By A. Elliott and (viii) Rotational isomerism about C-C bonds in saturated molecules as studied by vibrational spectroscopy: By N. Sheppard.

In the series of volumes proposed, all the diverse aspects of spectroscopy, viz., atomic, molecular, emission and absorption, and their relation to physics, chemistry, biology, astrophysics and other allied fields are expected to be covered. The several articles in the first volume present excellent reviews of the recent advances in the different branches of the subject and the series promises to be of much value and interest to workers in this field.

K.

Linear and Stereoregular Addition Polymers

By N. G. Gaylord and H. F. Mark. (Interscience Publishers, New York), 1959. Pp. x + 571. Price \$ 17.50.

The brilliant discovery of the Ziegler catalysts has opened up a new field of polymer research in the last decade. With this discovery a new discipline, that of stereospecific polymerisation, has been added to chemical science, and further an ever-increasing range of plastics and elastomers have been developed for commercial exploitation. The new catalytic systems have attracted a great deal of academic and industrial research and the opportune arrival of this second volume of *Polymer Reviews* including the mass of available information on the new developments up to March 1959 which exist mainly in patents and other inaccessible forms would be welcome by researchers everywhere.

The book opens with a brief introduction laying stress on the significance of controlled propagation reaction in bringing about stereospecific polymerisation which is followed by a brief review of kinetics of homogeneous addition polymerisation. The next chapter deals with surface adsorption and complete formation in a lucid way where we are introduced to novel

and expressive terms like 'reeling off' and 'spooling off' of polymer chains. Then follow short useful three chapters on requirements for stereospecific polymerisation, structure of olefin polymers in the solid state and solution properties of stereospecific polymers. The title of the next chapter (Fluid-Bed processes: also Chapter IX, title Fixed-Bed....) on Zeigler catalysts is misleading. It deals exhaustively with the preparation of the catalytic systems, polymerisation procedures and stereospecificity of the polymers formed. The details of synthesis of aluminium alkyls, safeguards in their handling, isolation of polymers formed and kinetics of polymerisation and co-polymerisation contained therein would be found most useful by research students. Chapters VIII and IX relate to other catalytic systems used for stereospecific polymerisation, viz., alfin catalysts, lithium metal catalysts and finally the industrially important metal oxide catalysts. Polymerisation of alkyl vinyl ethers has also been included. The interesting polymerisation of olefin oxides yielding optically active polymers is described next, followed by data on physical properties of linear and stereoregular polymers and compared with those on hitherto known polymeric materials. The succeeding chapter covers most of the patent examples tabulated on the basis of the nature of the processes, monomers involved and composition of catalysts, but in view of the incipient stages of development of the subject, it is difficult to be authoritatively critical. This rather voluminous chapter reflects the immense labour involved in compiling data from the rapidly increasing but unfortunately confusing patent literature and testifies to the diligence and efficiency with which it has been pursued and accomplished. Miscellaneous organo-metallic catalysed polymerisation systems are next dealt with though with many of these it has not been unambiguously settled that stereoregulation of polymers results. The appendix serves to bring in much of the information published during the preparation of the book and bring it up to date till March 1959. The book closes with subject, author and patent indices which cover the book most efficiently.

By presenting together in a stereospecific manner such a volume of information from a variety of sources and helping the specialist to keep abreast of the existing literature on stereospecific polymerisation, this book serves a valuable purpose supremely well. For this, polymer

chemists all over the world would feel greatly indebted to the experienced and well-known authors Professor Mark and Dr. Gaylord. In the context of the difficulties involved in the preparation, the occurrence of a few minor errors like spelling of adsorbents as 'adsorbens' throughout Chapter III and the representation of terminal vinyl group as $\text{CH}_2 = \text{C}$ instead of $\text{CH}_2 = \text{CH}$ on page 70 at bottom of Table V-3 cannot be considered serious.

The intention is mentioned in the preface about incorporating fresh results in subsequent supplements to this volume. One would also hope for a revised critical edition as soon as the fundamental principles of mechanism and control of formation of stereoregular polymers are better understood. Probably then some of the results and comments of questionable validity included here may need to be deleted or corrected. But even then the present volume would be the best basis to start with.

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S. L. KAPUR.

The Chemistry of Heterocyclic Compounds s-Triazines and Derivatives. By Edward M. Smolin and Lorence Rapoport. (Interscience Publishers, New York), 1959. Pp. 644. Price \$ 30.00.

It is surprising that a monograph of over 600 pages could be brought out on the relatively little-known s-triazine ring-system and derivatives thereof. The parent compound s-triazine has itself been recognized as such only since 1954 and displays a nuclear instability quite unlike any of its derivatives and in apparent contradiction with its high resonance energy.

After dealing with s-triazine in the introduction, the authors present a lucid account of important derivatives of this ring-system in ten chapters. Some of these like cyanuric acid, cyanuric chloride, melamine and hexamethylenetetramine have been among the earliest organic compounds known and studied. In each chapter, after tracing the history of the compound under discussion and detailing its physical properties, methods of synthesis are extensively and critically discussed, followed by an outline of the typical reactions of the compound and its uses in chemical industry. Each of the chapters is liberally interspersed with tables in which are listed all known compounds of a particular group, giving the melting-points and relevant references.

Organic chemists not familiar with patent literature will be most surprised at the extensive use made of s-triazine derivatives in various

fields of industrial chemistry, in the manufacture of dyes with special properties, of optical bleaches, of special types of explosives, synthetic resins and medicinal chemicals. The ingenious idea of linking up different molecules through a *s*-triazine ring by the agency of the highly reactive cyanuryl chloride has been very thoroughly exploited. Those concerned with the development of new products in the organic fine chemical industry will be greatly benefited by a study of this monograph. Those interested in structure elucidation will find many compounds of interest whose structures rest on slender and inconclusive evidence, offering scope for further work. The discussion of the chemistry of *s*-triazaborane and its derivatives in the last chapter is most useful, since information on this subject is widely dispersed and difficult to collect.

In conclusion, the monograph under review is an excellent production both in content and format and should be accessible to all organic chemists.

T. R. G.

Organic Chemistry. By Donald J. Cram and George S. Hammond. (McGraw-Hill Book Co., Inc., New York), 1959. Pp. xv + 712. Price \$ 8.50.

A new approach to organic chemistry has been presented in this text-book. Instead of the usual taxonomy of the subject into organic compounds with characteristic groups, the book is based on the classification of organic reactions under the judicious headings of nucleophilic and electrophilic substitutions at saturated carbon, nucleophilic and electrophilic substitutions at unsaturated carbon, nucleophilic, and electrophilic and other additions, elimination reactions, free radical reactions, and molecular rearrangements. The eleven chapters devoted to the above topics (Chaps. 10-20) together with the five chapters (Chaps. 5-9) which precede and deal with the chemical bond, stereochemistry, and structure and reactivity, present the principles of organic chemistry in a most intelligible manner and fulfil the authors' expectation of taking the student to the frontiers of research in the subject. The organic compounds themselves have been divided into hydrocarbons (Chap. 2), Compounds with functional groups saturated (Chap. 3) and unsaturated (Chap. 4) at carbon.

It is unfortunate that Chapters 21-24 dealing with heterocyclic compounds, steroids, peptides, alkaloids, carbohydrates, flavones, etc., have been made extremely brief. The section on mono-

terpenes include just two reactions, the ring closure of citronellal to isopulegol, and the aromatisation of citral to *p*-cymene. The three subsequent chapters deal with polymers, petroleum, and dyes and spectra.

Apart from the new approach to the subject the book differs from the usual text in several points. A large amount of space is devoted to figures, charts, illustrations and tables, in neat blocks, which expound the subject lucidly and make the book very handy for revision and easy reading. Molecular orbital representation of the several types of bonds in various molecules, drawing of molecular models emphasising the configuration of atoms in molecules, a short chapter on nomenclature of organic compounds (Chap. 28) and a few pages devoted to the literature of organic chemistry (Chap. 29) are features which deserve praise. The graded problems given at the end of each chapter will be welcome by earnest students.

The book has been brought out in excellent format for which the publishers have to be commended. For the presentation of the theory and principles of organic chemistry few books equal this one, and the book is warmly recommended for teachers and students.

G. B.

Biochemical Society Symposium—Glutathione. Edited by E. M. Crook. (Cambridge University Press, London N.W. 1), 1959. Pp. 118. Price 22 sh. 6 d.

The book under review, which contains the proceedings of the symposium on glutathione held under the auspices of the Biochemical Society in the United Kingdom, can be considered as a very useful supplement to the Ridgefield symposium held on the same subject in 1954 in the United States. Various chemical aspects of this naturally occurring peptide as well as its biochemical significance have been presented in this volume. The article of F. A. Isherwood is particularly noteworthy for its concise presentation of the chemistry of glutathione. C. G. Thomson and H. Martin in their article discuss the relative advantages and disadvantages of the iodate, amperometric and enzymic procedures for glutathione assay, while L. W. Mapson has reviewed the present evidence in favour of a role for glutathione-ascorbic acid system in cell respiration. Dr. Mapson has followed up the line of reasoning developed earlier by him with experimental data obtained in recent years, and has emphasised the importance of sulphhydryl compounds as regulators of cell metabolism.

Several aspects of glutathione metabolism in animals have been briefly reviewed by Jocelyn, while the lucid article by H. M. McIlwain is specifically concerned with the role of glutathione in cerebral tissue metabolism. The presence of glutathione and its analogues in the lens of the eye has been described by S. G. Waley while the role of thiols in relation to radiation damage has been outlined by D. B. Hope. On the whole, this volume can be considered to be an excellent compilation of a large amount of data obtained on various aspects of glutathione in recent years, presented in a concise and readable form. It should prove particularly useful to all research workers, interested in the biochemistry and metabolism of this important naturally occurring tripeptide. P. S. SARMA.

Principles of Agronomy. Second Edition. By V. T. Subbiah Mudaliar. (S. Viswanathan, Madras), 1959. Pp. xx + 487. Price Rs. 17.50. The publication of the Second Edition within three years of its first publication (1956) shows the demand and popularity of this text-book with the students and staff of Agricultural Colleges in India.

The Second Edition is the same as the first except for the incorporation of some additional information and illustrations. The new Chapter on Weeding with factual data on the theoretical and practical aspects of the operation, including the various types of tools that are employed and chemicals that are used for the purpose, is a welcome addition. Some of the more recent developments in the science like use of radio-isotopes for the study of plant functions, foliar feeding of plants, functions of chelates, etc., have been incorporated in broad outlines and written in simple language, making it easy reading for everyone. The book is one of the best that could be recommended to students of agronomy in India.

The get-up and binding of the book, however, could be improved to a considerable extent, as I found some pages coming off loose even in the new book.

G. RANGASWAMI.

Books Received

Antibiotics in Medicine. (British Medical Bulletin, Vol. 16, No. 1.) (Medical Development, The British Council, 65 Davies Street, London W. 1. Oxford University Press), January 1960. Pp. 1-88. Price 20 sh.

The Real Projective Plane. 2nd Edition. By H. S. M. Coxeter. (Cambridge University Press, London N.W. 1), 1960. Pp. xi + 226. Price 18 sh. 6 d.

Advances in Pest Control Research, Vol. III. Edited by R. L. Metcalf. (Interscience Pub., New York), 1960. Pp. vii + 448. Price \$ 14.50.

Cambridge Monographs on Physics: Cosmology, (2nd Edition). By H. Bondi. (Cambridge University Press, London N.W. 1), 1960. Pp. 182. Price 30 sh.

Captured Stars. By Heinz Letsch. (Veb Gustav Fischer Verlag, Jena), 1959. Pp. 183. Price DM 16.

Fundamentals of Mathematics. By Elbridge P. Vance. (Addison-Wesley Pub. Co., Inc., Reading, Mass., U.S.A.), 1960. Pp. x + 469. Price \$ 5.50.

Principles of Electricity and Magnetism. By E. M. Pugh and E. W. Pugh. (Addison-Wesley, Pub. Co., Inc., Reading, Mass., U.S.A.), 1960. Pp. xi + 430. Price \$ 6.50.

Foundations of Electromagnetic Theory. (Addison-Wesley Pub. Co., Inc.), 1960. Pp. xi + 387. Price \$ 6.50.

Annals of the New York Academy of Sciences: Vol. 84, No. 4—The Organisation of Psychiatric Care and Psychiatric Research in the Union of Soviet Socialist Republics. By Nathan S. Kline, 1960. Pp. 147-224. Price \$ 3.00.

Vol. 84, No. 5—A New Method for Cytological Diagnoses of Pulmonary Cancer. By L. Von Bertalanffy and F. D. Bertalanffy, 1960. Pp. 225-50.

Vol. 84, No. 6—The Kinetics of Reactions of Changing Temperature. By C. Olin, Ball, 1960. Pp. 239-50.

Vol. 85, No. 2—Freezing and Drying of Biological Materials. By H. T. Meryman, H. Fernandez-Moran and others, 1960. Pp. 501-734.

The Chemistry of Natural Products (Vol. IV)—The Natural Pigments. By K. W. Bentley. (Interscience Pub., New York), 1960. Pp. vii + 306. Price \$ 5.00.

Antibiotics Annual, 1959-60. Edited by Henry Welch, Felix Marti-Ibanez (Antibiotica Inc., New York, N.Y.), 1960. Pp. xvii + 1034. Price \$ 15.00.

Nepal—a Cultural and Physical Geography. By Pradyumna P. Karan (with the collaboration of William M. Jenkins). (University of Kentucky Press, Lexington), 1960. Pp. 100. Price \$ 10.00.

Fishing Boats of the World—II. Edited by Jan-Olof Traung. (Fishing News, Books Ltd., Ludgate House, London E.C. 4), 1960. Pp. 781. Price £ 7-7-0.

SCIENCE NOTES AND NEWS

A Simple Experimental Arrangement to Study Zeeman Effect

Messrs. G. M. Sreekantath, A. O. Mathai and K. S. Nair of the Department of Physics, University College, Trivandrum, describe a simple experimental arrangement that can conveniently be used in an undergraduate laboratory to study Zeeman effect. When a glass plate with optically plane surfaces is mounted vertically on a spectrometer table and the reflected image of the wide slit illuminated by monochromatic light is viewed through the telescope, generally, interference fringes are observed at all angles of incidence. If, however, the light, instead of being strictly monochromatic, consists of two close wavelengths of comparable intensities, the system of fringes vanishes at certain discrete angles of incidence. A measurement of these angles and the angular separation of the fringes enables one to calculate the mean wavelength and the difference in wavelength.

If the slit is illuminated by a neon wavelength obtained from a neon tube placed between the poles of an electromagnet, striking periodic changes in the visibility of the fringes are observed as the strength of the magnetic field is gradually increased; the fringes vanishing for changes in wavelength $\pm \delta\lambda = \text{odd multiple of } \lambda^2/4\mu d$, where d is the thickness of the plate and μ its refractive index. This optical arrangement is found to be sensitive enough to measure such changes in wavelength as occur in Zeeman effect.

Effect of Gibberellic Acid on the Germination of Pollen and Pollen Tube Growth

A. S. Dubey, Lecturer in Botany, Patna University, Patna-5, writes that he observed while working on the role of gibberellic acid in pollen germination and pollen tube growth that gibberellic acid at a concentration of 900-1,000 parts per million increased germination percentage and growth of pollen tubes of *Lathyrus odoratus* and *Vicia faba* in vitro.

Allahabad Agricultural Institute—Golden Jubilee Celebrations

The Allahabad Agricultural Institute, a Christian Institute of Rural Life, founded by Sam Higginbottom in 1910, has been a pioneer institution in the field of Agriculture in the

country. From humble beginnings the Institute has grown into an important centre of agricultural teaching, research and extension. The Institute will be celebrating its golden jubilee during the week 23-30 October, 1960.

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Technology to Sri. G. V. Jagannadha Raju for his thesis entitled "Studies on Batch Fluidized Beds".

Symposium on "Advancing Frontiers of Life Sciences"

A symposium on 'Advancing Frontiers of Life Sciences' will be held at the time of the Silver Jubilee Celebrations of the National Institute of Sciences at New Delhi in the last week of December, 1960.

The scope of the symposium will be: (a) Sciences concerned with plant life (Botany)—Embryology, Morphogenesis, Cytology, Histology, Plant Ecology, Plant Physiology, etc. (b) Sciences concerned with animal life (Zoology)—Anatomy, Embryology, Histology, Cytology, Genetics, Animal Ecology, etc. (c) Sciences concerned with function in plant and animal organism (Plant and Animal Physiology, Cellular Physiology, etc.), Human Physiology and Pharmacology. Interactions of co-ordinating systems, e.g., nervous system, muscle-skeletal system, hormonal systems, circulatory system, etc. Factors bringing about an alteration of functions of cells through physical and chemical agents. (d) Chemical and Physical aspects of Cells and Organisms (Biochemistry and Biophysics)—Structure and Cellular Functions—Mechanism of Protein Synthesis—Chemical Basis of heredity—Basic Proteins in Defence and Immunity; (e) Techniques and Instrumentation—Radioisotopes, Chromatography, Electrophoresis, Ultrasonics, Radiation Biology, Radio-autography, X-ray Diffraction, Electron-microscopy, Polarisation-microscopy, Tissue Culture, Ultracentrifuge, etc. etc.

An abstract of the paper (in duplicate) not exceeding 250 words should be sent to the Convener before 30th September 1960.

For further information please write to Dr. B. Mukerji, Convener and Director, Central Drug Research Institute, Lucknow.

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Deep-Sea Fungi

Research work carried out by the German ship *Anton Dohrn* during the International Geophysical Year proves the existence of fungi in deep sea. A sample taken from the sea floor (at a depth of 3,425 m., 200 miles south of Greenland) contained not only phycomyces (low fungi) but also higher fungi which would grow on introduced sterilized organic material like pollen or straw. It is believed that such fungi are key-producers of vitamins in regions where green plants do not thrive.

Cell Cultures and Proteins

Methods for the cultivation of mammalian cells *in vitro* provide an important tool in the field of virus and cancer research. Many types of mammalian cells have been grown, practically indefinitely, outside the animal or human body in glass or steel vessels containing suitable nutrient media. Most of these media contain in addition to various salts, amino-acids and vitamins, substances such as serum, amniotic fluid, embryo extracts, etc. Serum was believed until recently to supply essential proteins; without serum the cell cultures could not become "established", i.e., could not be propagated serially for prolonged periods of time.

The recent study of H. Eagle (*Proc. Nat. Acad. Sci. of the U.S.A.*; Vol. 46, p. 427) indicates that proteins *per se* are not essential, and that the primary role of the serum protein in suspension cultures of mammalian cells is to provide some necessary growth factors in the form of small molecules; these factors are either bound to protein or are formed from it when it is broken up by a suitable enzyme.

Plastic Capillaries as Containers for X-ray Diffraction Samples

Plastic capillaries are often useful in X-ray diffraction work, as containers for materials which are reactive with glass but need to be protected from air, moisture and carbon dioxide. These capillaries can be conveniently drawn from polystyrene and from polyethylene tubing.

A section of tubing may be heated in a coil of nichrome wire and the temperature controlled with a variable transformer. The pulling technique is quite different from that used for glass. Plastic must be pulled very slowly and the temperature kept near the softening point. Polystyrene may be pulled conveniently while still in the heating coil and should be pulled continuously until the proper size is attained. Polyethylene capillaries are obtained by heat-

ing to the softening temperature and then pulling outside the coil. A hot wire serves to cut or seal polystyrene capillaries while polyethylene capillaries may be sealed with hot pliers.

Different patterns of the empty capillaries show some lines which are characteristic of the partly crystalline plastics, but these may be identified and do not interfere greatly with stronger patterns of contained powders.—*Rev. Sci. Inst.*, 1960, 31, 574.

Ultrasonic Absorption and Velocity in Water Containing Algae in Suspension

Since large areas of the ocean have an abundance of plankton in suspension, it will be interesting to study the effect of plankton on sound propagation in water. Meister and St. Laurent have reported (*J. Acous. Soc. Amer.*, 1960, 32, 556) the results of their investigations on the ultrasonic absorption and velocity of longitudinal waves in water containing suspended algae (*Scenedesmus*), using different frequencies and with suspensions of different concentrations.

The velocity of the ultrasonic wave is found to be constant regardless of the concentration, and equal to the velocity in freshwater. The total ultrasonic absorption is found to be a linear function of the concentration. This indicates that there is practically no interaction between the particles. The results also indicate that scattering is not a mechanism for absorption.

Dynamic Determination of the Elastic, Dielectric and Piezo-Electric Constants of Quartz

Several dynamic determinations have been made of the constants of quartz. Most of these determinations do not take into account the piezo-electric effect; those that do, suffer from certain other deficiencies. In a Monograph (National Bureau of Standards, Washington 25, D.C.) A. S. Basri presents derivations of expressions for the frequency of longitudinal vibration of rectangular bars, and thickness shear vibration of infinite plates (taking into account the piezoelectric effect) and applies them to the determination of the constants of quartz.

On the basis of present theoretical knowledge, it is suggested that the best procedure is to measure the frequency of vibration of two particular cuts for rectangular bars and seven cuts for plates, and to measure the capacitance at zero frequency of a rectangular bar. These ten measurements provide the data for determining the six elastic, two dielectric, and two piezo-electric constants of quartz uniquely.

Ruby Maser

A super-sensitive electronic listening device, known as a ruby maser amplifier, is expected to advance peaceful exploration of distant planets, tracking of satellites and space probes, etc.

The 'heart' of the device is a crystal of synthetic ruby. In use, the ruby is cooled by liquid helium to -452°F . at which temperature, the jewel's atoms and electrons move in slow motion, reducing the natural 'noisy' collisions of atomic particles.

The absence of atomic collisions enables the ruby maser to detect and amplify almost unbelievably faint radio signals that are obscured in conventional amplifiers.

The ruby maser is easily operated, weighs only 25 pounds and is so small that all parts, apart from the antenna, are housed in a portable cabinet about the size of a television console. Prior to the development of this small device by the Hughes Aircraft Company, a maser was a stationary object that required a large vacuum pump and an expensive magnet weighing up to 500 pounds. The ruby maser is portable and less expensive, needing no pump at all, and a permanent magnet that weighs only 12 ounces.—*Atoms for Peace Digest*.

Metal Zone-Plate to Focus Extreme Ultra-violet and Soft X-rays

In the wavelength region between 10 Å and 1000 Å, ordinary lenses and mirrors fail as image-forming devices because the transmissivity and reflectivity of materials are very low. In this region diffraction offers a means of bending rays and focusing them.

A. V. Baez describes in *Nature*, 1960, 186, 958, a Fresnel zone-plate consisting of 19 metal zones held together by thin radial struts so that the transparent zones are empty. This permits soft X-rays and ultra-violet radiation to pass through and be focused. The device has been tested with visible light and ultra-violet light down to 2537 Å. It behaves as expected in terms of speed and resolution, leading to the conclusion that it should focus well even at wavelengths less than 100 Å.

The zone-plate has a central circle of diameter 0.04 cm., and outer circle of diameter 0.26 cm., and is about 10 microns thick. The narrowest gold band has a width of 20 microns.

It was made by the Buckbee Mears Company of St. Paul, Minnesota, by techniques that are an outgrowth of the lithographic art.

Elastic Behaviour of Matter under Very High Pressures

The elastic behaviour of substances, which are already in a highly strained state, is a subject of considerable importance, in its fundamental aspects as well as in its application to important questions like the constitution and stability of massive entities such as exist in the interior of the Earth. Matter in the interior of the Earth is subjected to large stresses, resulting in an accumulation of great amounts of strain energy. It is known that periodical releases of the strain energy, thus accumulated, manifest themselves as earthquakes in various regions. It is also known that shear waves are not sustainable in the interior of the Earth below a depth of about 3,000 km., while up to that depth from the surface, compressional as well as shear waves are present. An explanation of these remarkable phenomena would necessarily involve a knowledge of the elastic behaviour of matter at the depths in question, and a first step in this direction would be the evaluation of the elastic constants of substances, which are already under great strains, in terms of known parameters.

Dr. Bhagavantam and E. V. Chelam in a paper contributed to the *Proceedings of the Indian Academy of Sciences* (1960, 52, 1) have derived expressions for these quantities for a substance of cubic symmetry on the basis of non-linear theory of elasticity and including up to cubic powers of the strain components in the strain energy function. A simple method of deriving them directly from the energy function itself has been indicated for any general case and the same has been applied to the case of hydrostatic compression. The notion of an "effective elastic energy"—the energy required to effect an infinitesimal deformation over a state of finite strain—has been introduced, the coefficients in this expression being the "effective elastic constants". A separation of this effective energy function into normal co-ordinates has been given for the particular case of cubic symmetry and it has been pointed out, that when any of such coefficients in this normal form becomes negative elastic instability will set in, with associated release of energy.

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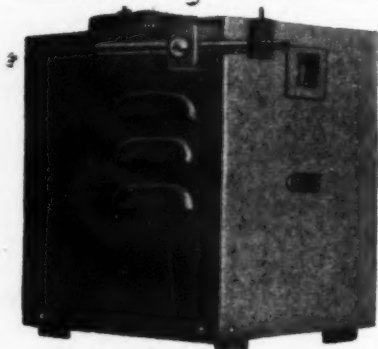
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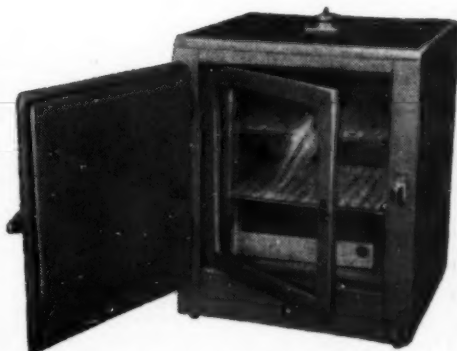
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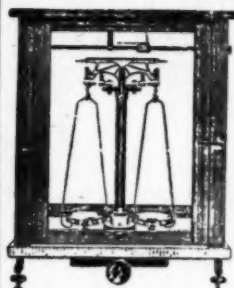
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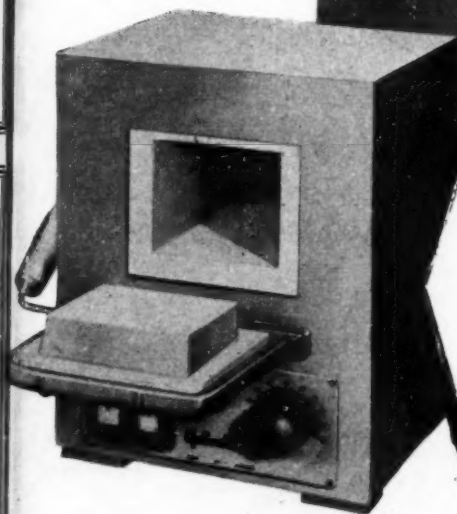
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